SCIENCE

27 September 1957

Volume 126, Number 3

50035

Editorial Shifting the Burden 597

Articles Ethological Concepts: *R. F. Ewer* 599

W. C. Mendenhall, Geologist: *D. F. Hewett* 603

R. S. Lull, Vertebrate Paleontologist: *J. T. Gregory* 604

News of Science News Articles and Briefs; Scientists in the News; Recent Deaths 605

Reports Paper Chromatography of Unstable Substances: *K. Schwarz* and *A. A. Bitancourt* 607

Effect of Cyanide on Biosynthesis of Ascorbic Acid *in vitro*: *I. B. Chatterjee* et al. 608

Composition of the Placental Septa as Shown by Nuclear Sexing: *A. Sadovsky, D. M. Serr, G. Kohn* 609

Stimulant Effect of 2-Dimethylaminoethanol—Possible Precursor of Brain Acetylcholine: *C. C. Pfeiffer* et al. 610

Evidence that Glucamine Is a Precursor of Asparagine in a Human Cell in Tissue Culture: *L. Levintow* 611

Acquisition of Resistance to Osteolathyrism during Adaptation to Cold: *H. Selye* 612

Thorium Content of Stone Meteorites: *G. L. Bate, J. R. Huizenga, H. A. Potratz* 612

Effects of Gamma Radiation on Collembola Population Growth: *S. I. Auerbach, D. A. Crossley, Jr., M. D. Engelman* 614

Book Reviews *Bioenergetics; Educating Gifted Children; Plant Virus Serology; Development of Vertebrates; The Genus Achlya: Morphology and Taxonomy*; Books Reviewed in *The Scientific Monthly*; New Books 615

Meetings and Societies Election of AAAS Officers; Forthcoming Events 618

Equipment News 625

MERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Nuclear-Chicago offers complete new nucleonic laboratory instrumentation

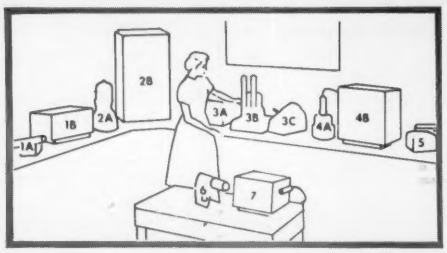
More than two years' research went into the 33 *all new* instruments that have been added to the Nuclear-Chicago line now offered to the small or large nucleonic research laboratory. Among these high-quality advance-design instruments are many completely automatic counting systems.

Whether you are just starting a modest radioisotope laboratory or expanding present facilities, call on Nuclear-Chicago. For complete details on the new Nuclear-Chicago line, write for our new Catalog "Q".

1A Model DS5-3P Scintillation Detector with exposed 2" x 2" sodium iodide crystal and **1B** Model 132 Analyzer Computer for precision gamma-ray measurements using pulse-height discrimination techniques.

2A Model DS5-5 Scintillation Well Counter with exclusive "scaler-spectrometer" circuit and **2B** Model 1820 Recording Spectrometer for automatic quantitative energy separation of gamma-ray spectra.

3A Model 183B Count-O-Matic Binary Scaler, **3B** Model C110B Automatic Sample Changer with Model D47 Gas Flow Counter, and **3C** Model C111B Printing Timer for completely automatic changing, counting, and recording of as many as 35 soft beta emitting radioactive samples.



4A Model 3054 Manual Sample Changer with Model DS5 Scintillation Detector which features interchangeable alpha, beta, or gamma sensitive crystals connected to Nuclear-Chicago's finest scaler, the **4B** Model 192A Ultrascaler. Model 192A features decade scale of 10,000, one millivolt sensitivity, and precision automatic circuitry.

5 Model 2612P Portable Survey Meter contains a 1.4 mg/cm² thin window G-M tube for surveying for alpha, beta, or gamma contamination up to 20 milliroentgens per hour.

6 Model 2586 "Cutie Pie" features interchangeable ionization chambers for measuring beta, gamma, or x-radiation up to 250 roentgens per hour.

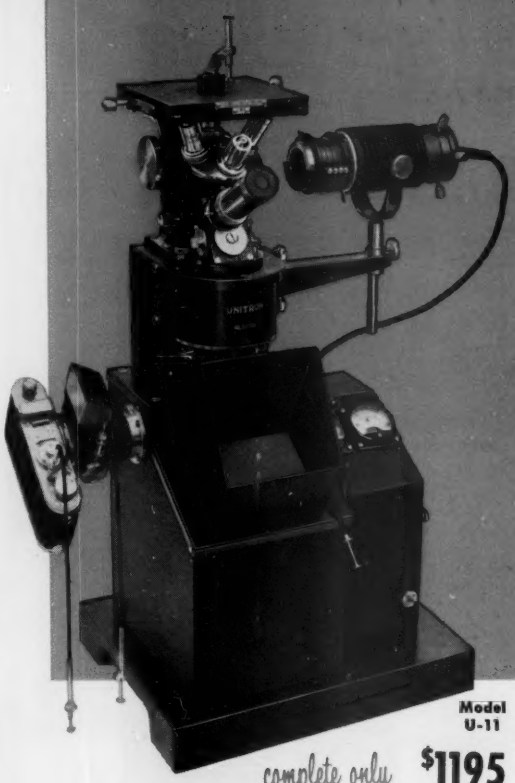
7 Model 1620A-S Analytical Count Rate Meter offers a wide choice of full scale ranges, four time constants, wide range high voltage supply. It is shown with a Model D34 thin window G-M tube and P11 probe for continuous monitoring or analytical radioactivity determinations.

nuclear-chicago
CORPORATION
237 WEST ERIE STREET • CHICAGO 10, ILLINOIS

These typical 17 together took 71

Here are 17 discriminating buyers whose 71 orders and reorders prove complete satisfaction with these UNITRON instruments.

AMERICAN BRASS	MINNEAPOLIS HONEYWELL
CARNEGIE INSTITUTE	UNION CARBIDE & CARBON
E. I. DU PONT	MISSOURI SCHOOL OF MINES
GENERAL ELECTRIC	REYNOLDS METALS
GENERAL MOTORS	U. S. GOVERNMENT
GOODYEAR ATOMIC	UNIV. OF CINCINNATI
I. B. M.	UNIV. OF WASHINGTON
M. I. T.	WESTINGHOUSE ELECTRIC
	R. C. A.



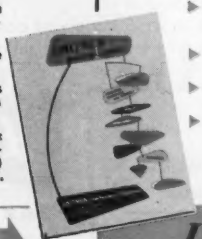
Model U-11

complete only $1195

BINOCULAR MODEL only $1379

UNITRON METALLOGRAPH and Universal Camera Microscope, Model U-11: A completely self-contained instrument of modern design for visual observation, photography, projection and measurement of both opaque and transparent specimens, using bright-field, dark-field or polarized illumination. While compact in size, it duplicates the performance of large, cumbersome instruments. Even laboratories on a limited budget can enjoy the accuracy, speed and efficiency possible only with a complete installation of this type.

- Standard optics include 5 parfocal objective lenses with revolving nosepiece, 4 photographic eyepieces on a revolving turret, 3 visual eyepieces, all coated. Magnification range: 25–2000X.
- High-intensity illuminator with variable transformer built into the microscope base.
- Built-in 3¼" x 4¼" camera. The image is automatically in focus in the camera and transition from observation to photography is instantaneous.
- Calibrated square mechanical stage with calibrated rotatable stage plate.
- Calibrated polarizing apparatus, transmitted-light accessories for transparent specimens, filters, micrometer eyepieces, film holders, cabinets, dustcovers, etc. all included.
- Additional accessories, available at extra cost include: Polaroid Land Camera attachment for "60-second" photography; 35mm camera attachment; low power (5–40X) objectives; vacuum heating stage for temperatures to 1100°C.



Model MEC

complete only $399

BINOCULAR MODEL only $599

UNITRON INVERTED Metallurgical Microscope, Model MEC: Many of the features of the UNITRON Metallograph U-11, which are connected with visual observation of opaque specimens, are included in this compact unit. Think of the time which can be saved in your laboratory by providing each metallurgist with one of these handy, inexpensive units for use at his desk. Model MEC is also ideal for use together with a polisher or microhardness tester.

- Standard optics include 4 parfocal objective lenses: 5X, 10X, 40X, 100X oil immersion on revolving nosepiece; 3 eyepieces: P5X, Micrometer 10X, K×15X, all coated. Magnification range 25–1500X.
- Vertical illuminator with iris diaphragm. Transformer housed in microscope base. A microswitch on the base provides an extra high intensity for photography.
- Binocular model has provision for attaching 35mm camera to microscope base. A 35mm camera attachment is available to attach to the eyepiece tube of the monocular model.
- Calibrated square mechanical stage with calibrated rotatable stage plate.
- Calibrated polarizing apparatus, 5 filters, dustcover, cabinet, etc. all included.
- Additional accessories available at extra cost include: 35mm camera attachment; K20X eyepiece for 2000X; transmitted-light accessories for transparent specimens; vacuum heating stage.

THIS COMPLETE CATALOG ON UNITRON MICROSCOPES IS YOURS FOR THE ASKING

FREE 10 DAY TRIAL on any UNITRON MICROSCOPES . . .

Let the instrument prove its value to you — in your own laboratory — before you decide to purchase.

UNITRON INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.

204-206 MILK STREET • BOSTON 9, MASS.

Please send me your complete catalog on UNITRON Microscopes.

Name and Title _____

Company _____

Address _____

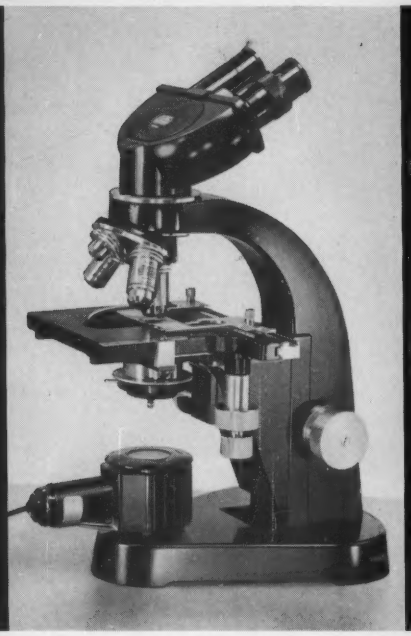
City _____ State _____

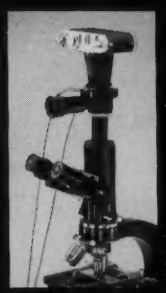
SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢.

A NEW CONCEPT IN MICROSCOPE PERFORMANCE

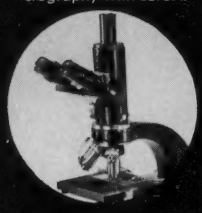
Leitz LABOLUX

LABOLUX S 47/92-15 inclined binocular microscope, with built-in mechanical stage #47, Abbe condenser; quadruple nosepiece with achromats 3.5x, 10x, 45x and 100x oil immersion, the last two having spring-loaded mounts; paired 6x and 10x binocular eyepieces; with carrying case $696.50





LABOLUX for photomicrography with LEICA.



Combined binocular-monocular tube.

The Leitz LABOLUX medical and laboratory microscope is a scientifically engineered instrument of modern design, built for a lifetime of use. The LABOLUX is a new concept in fatigue-free operation and precision performance. It combines the coarse and fine focusing adjustments in a single control; with all controls, including the actuating knob for the mechanical stage, in a low convenient position. High power lenses have spring-loaded mounts preventing damage to lenses or slides.

The LABOLUX can be faced away from the observer, for increased accessibility to all controls and to the object stage. Interchangeable body tubes permit binocular or monocular observation as well as photomicrography, with simultaneous observation and photography made possible through a unique trinocular attachment. A wide variety of accessories makes the Leitz LABOLUX the ideal instrument for hospital or office laboratory.

E. LEITZ, INC., DEPT. SC-9
468 Fourth Ave., New York 16, N.Y.

Please send me the Leitz LABOLUX brochure

Name_____

Street_____

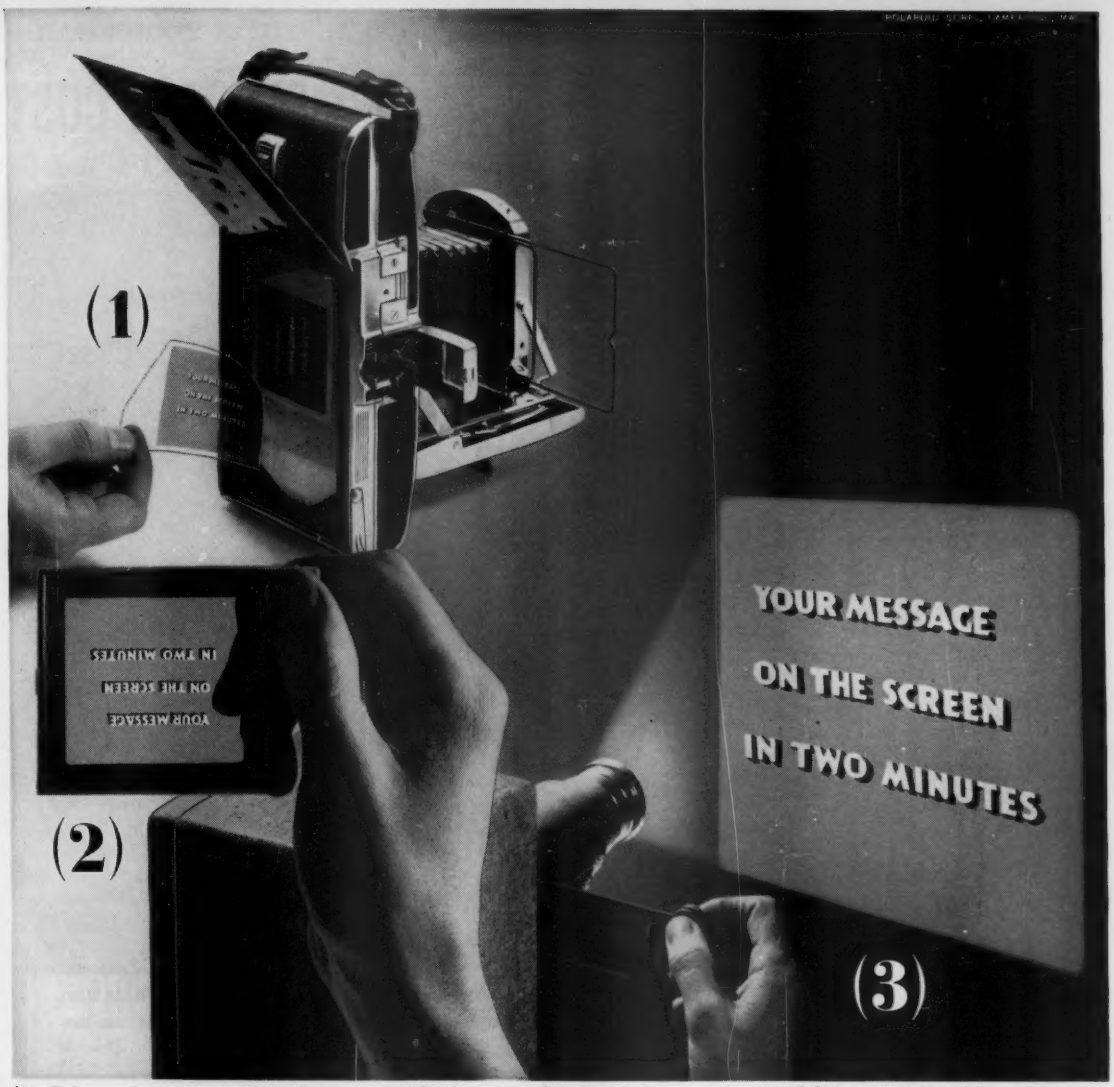
City_____ Zone_____ State_____

Leitz

FIRST IN PRECISION OPTICS

20557

E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N.Y.
Distributors of the world-famous products of Ernst Leitz G.m.b.H., Wetzlar, Germany—Ernst Leitz Canada Ltd.
LEICA CAMERAS · LENSES · MICROSCOPES · BINOCULARS



(1) Take a picture one minute, have your slide the next. (2) Slip it into a mount, and (3) project it as big as you want.

Polaroid Corporation Announces

QUICK, EASY WAY TO MAKE SLIDES

Now, with a standard Polaroid® Land Camera you can make slides in an office, lab or plant, and project them immediately.

Polaroid Corporation has perfected a film which produces black-and-white slides right in a *regular* Polaroid Land Camera. Just click the shutter, pull a tab and lift out a transparency of exceptional photographic quality. It's ready to project 20 seconds later, after a quick hardening and mounting in a snap-together plastic mount.

The complete system includes the standard Polaroid Land Camera, the film, mounts, hardener and projector, plus a versatile Copymaker that lets you make slides from any text material, existing photographs, charts, graphs, titles or what have you. You have a choice of two sizes of film—2¼ x 2¼, or 3¼ x 4 (for existing "Lantern Slide" projectors).

These slides cost about one-third as much as conventional slides. But the real saving is in the time and effort that it takes to put a picture on the screen. Send in this coupon for more detailed information.

Polaroid Corporation
Dept. S9 · Cambridge 39, Mass.

Please send me detailed information on the new Polaroid Transparency System.

NAME_____

PROFESSION OR POSITION_____

INSTITUTION OR COMPANY_____

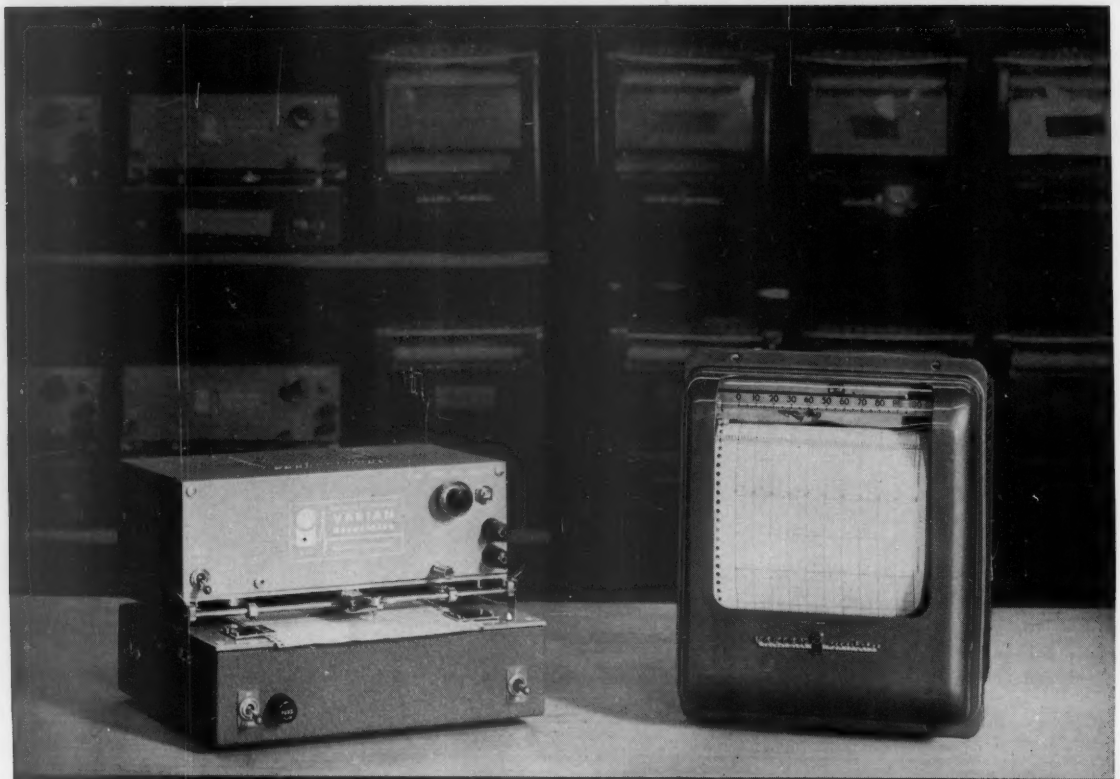
ADDRESS_____

CITY_____ ZONE____

STATE_____

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11 — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 18, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

ENTERTAINMENTS, PUZZLES . . .

T167. THE COMPLETE NONSENSE OF EDWARD LEAR. All original text, illustrations of all nonsense books Lear ever wrote, 5 books in 1. Dong with a Luminous Nose, Owl & Pussycat—hundreds of others. 546 illustrations. 320 pp. Paperbound $1.00

T1. FLATLAND, E. A. Abbott. Fictionalized life in 2 dimensions, offers techniques for visualizing multidimensional forms, etc., clearer than most texts. "Delightful," SCIENCE NEWS LETTER. 128 pp. Paperbound $1.00

T97. CRYPTANALYSIS, H. F. Gaines. Best intermediate text for serious student; modern techniques, much not usually known except to experts. 236 pp. Paperbound $1.95

T362. LEARN CHESS FROM THE MASTERS, F. Reinfeld. Play 10 games against masters and grade every move you make! 152 pp. Paperbd. $1.00

T162. MATHEMATICAL RECREATIONS, M. Kraitchik. Moderately advanced problems based on theory of numbers, topology, etc. Unequalled for easily assimilated insights. 330 pp. Paperbound $1.75

T295. HOW TO CALCULATE QUICKLY, H. Sticker. Tried & true method, over 9000 problems, to develop your number sense; techniques not taught in schools: division, multiplication, etc. 256 pp. Paperbound $1.00

T417. REINFELD ON THE ENDGAME IN CHESS, F. Reinfeld. Extremely easily followed presentation, stresses enormous range of wrong play, telling exactly what is wrong. Recommended. 183 pp. Paperbd. $1.25

T337. PUZZLE QUIZ STUNT FUN, Jerome Meyer. Mathematical puzzles, deductions, observations, etc. 238 in all. Entirely new. 256 pp. Paperbd. $1.00

T344. NEW WORD PUZZLES, G. L. Kaufman. 100 entirely new puzzles for enthusiasts of word games: chesswords, designonyms, addle letter anagrams. lapwords, acrostigrams, etc. 196 figures. 128 pp. Paperbd. $1.00

T110. MATHEMAGIC, MAGIC PUZZLES, GAMES WITH NUMBERS, H. V. Heath. One of most famous books in recreational math. 128 pp. Paperbd. $1.00

T384. HOUDINI ON MAGIC. Houdini's own account of magic tricks, picking locks, exposés of spiritualism, how stage magic works, etc. Incredible feats of greatest magician of modern times. 155 photos. 295 pp. Paperbd. $1.00

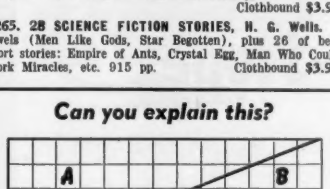
T198. MATHEMATICAL PUZZLES FOR BEGINNERS & ENTHUSIASTS, G. Mott-Smith. 188 mathematical puzzles of most delightful sort, detailed solutions. 248 pp. Paperbd. $1.00

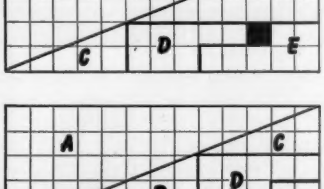
T143. BOOK OF MODERN PUZZLES, G. L. Kaufman. More than 150 word and logic puzzles, unusual types, highly original; no old chestnuts. 192 pp. Paperbound $1.00

T264. 7 SCIENCE FICTION NOVELS, H. G. Wells. Time Machine, Island of Dr. Moreau, 1st Men in Moon, Invisible Man, War of Worlds, etc. Full texts. 1015 pp. Clothbound $3.95

T265. 28 SCIENCE FICTION STORIES, H. G. Wells. 2 novels (Men Like Gods, Star Begotten), plus 26 of best short stories: Empire of Ants, Crystal Egg, Man Who Could Work Miracles, etc. 915 pp. Clothbound $3.95

Can you explain this?





Rearrange the parts of the top figure into the bottom one, and you lose one square of area. Mysterious, isn't it?

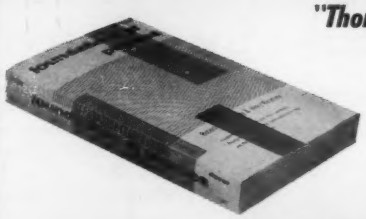
Let MARTIN GARDNER explain this and hundreds of other elements of mathematical magic!

MATHEMATICS, MAGIC AND MYSTERY
by Martin Gardner

How do geometrical vanishing tricks work? Why are card tricks possible? How can magicians do astonishing feats of mathematics mentally? As a rule, we accept these tricks as "magic," and do not recognize that they are demonstrations of probability, theory of numbers, topology, and other mathematics.

This is the first book-length study of this fascinating branch of mathematics. Written in the same delightful manner as Gardner's articles in the Scientific American, it summarizes all previous work in this field. It offers scores of new tricks, insights, puzzles, and aligns many effects with law for the first time. It discusses tricks with cards, coins, topological tricks, geometric vanish effects, etc. You will see how Sam Loyd could make a Chinaman vanish, how a Curry square "proves" that the whole is more than its part.

135 illustrations. xii + 174 pp. 5⅜ x 8.
T335 Paperbound $1.00



"Thorough, yet not overdetailed. . . unreservedly recommended."

NATURE [London].

NOW only $2.45

FOUNDATIONS OF PHYSICS
by R. B. Lindsay and H. Margenau

PARTIAL CONTENTS

I. MEANING OF PHYSICAL THEORY. Data, experiment, measurement, symbolism, laws, theory, math., abstraction, boundary conditions, integral, differential equations, etc. II. SPACE, TIME. Psychology vs. physics, geometry, etc. III. FOUNDATIONS, MECHANICS. Kinematics, position, displacement, velocity, acceleration, dynamical concepts, Newton, mass, force, motion, d'Alembert, Gauss, Hertzian mechanics. energy, canonical equations of Hamilton, etc. IV. PROBABILITY, APPLICATION. Probab. aggregates, Bernoulli's problem, emission of rays, Laplace's formula, density fluctuations, etc. V. STATISTICAL PT. OF VIEW. Dynamical, statistical theories, electrical current, thermodynamics, statistical mechanics, Gibbs, Darwin, Fowler, etc. VI. PHYSICS OF CONTINUA. Continuum, scalar, vector fields deformable media, tensor fields, electromagnetic fields, etc. VII. ELECTRON THEORY, SPECIAL RELATIVITY. Invariance of field equations, special theory, etc. VIII. GENERAL THEORY. Ideas, motion of particle in gravitational field, etc. IX. QUANTUM MECHANICS. Uncertainty, Hermitean operators, Schroedinger's equation, eigenvalues, matrices, spin, quantum statistics, Dirac, etc. X. CAUSALITY.

A bridge between semipopular works and technical treatises, this book analyzes foundation ideas and methods of modern theoretical physics. It is not a textbook, but a discussion of methods of physical description and construction of theory, with full cognizance of logic of science, physical data and their measurement, construction of experiment, and symbolic representation..

Intended for the intermediate or advanced reader who has some background in the sciences and some knowledge of calculus, it covers both classical and modern physics, contrasting their positions, and telling why transitions were made from classical to modern. It gives meaning to the bare data and tools of physics.

Reviews of the first edition. "A most unusual book . . . an interestingly fresh approach . . . will help [the reader] to discover that there is much more to his subject than is involved in adroit manipulation of differential equations, etc.," **E. U. Condon, REVIEW OF SCIENTIFIC INSTRUMENTS.** "At once thorough and yet not overdetailed; it may be unreservedly recommended," **NATURE** [London].

Index. Reading lists. 35 illustrations. xi + 537 pp. 5⅜ x 8. 8377 Paperbound $2.45

S413. INTRO. TO STUDY OF STELLAR STRUCTURES, S. Chandrasekhar. Unabridged republication of modern classic, costing up to $20 on o.p. market. 509 pp. Paperbound $2.75

S366. APPLIED OPTICS AND OPTICAL DESIGN, A. Conrady. Full unabridged inexpensive reissue of standard modern treatise. 528 pp. Paperbound $2.95

T203. ANIMALS IN MOTION, Eadweard Muybridge. Largest collection (over 4000 photos) ever made from famous Muybridge collection of high speed stopped action photos of animals in motion. Horses, cats, lions, guanacos, camels, sloths, elephants, 27 other animals, birds. 123 different types of action. Invaluable for biologists, zoologists, naturalists. New introduction by L. S. Brown, Am. Mus. Nat. Hist. Over 410 pp. 7⅞ x 10¾. Deluxe edition. Clothbound $10.00

S361. THERMODYNAMICS, Enrico Fermi. Clear elementary; "May be recommended as clear, very accurate introduction," J. of Phys. Chem. 170 pp. Paperbound $1.75

S289. MONOGRAPHS ON TOPICS OF MODERN MATHEMATICS, ed. W. Young. Foundations of geometry, non-Euclidean geometry, theory of numbers, calculus, for persons who have forgotten or never finished elementary college math. 432 pp. Paperbound $2.00

S109. VECTOR AND TENSOR ANALYSIS, G. E. Hay. Start with simple definitions, finish understanding vectors and tensors. 201 pp. Paperbd. $1.75

S133. TABLES OF FUNCTIONS, with formulae, curves, E. Jahnke, F. Emde. Most comprehensive 1 vol. collection. 394 pp. Paperbound $2.00

S164. INTRO. TO SYMBOLIC LOGIC, Susanne Langer. Even if you never finished high school algebra you can learn modern Russell-Whitehead logic. 338 pp. Paperbd. $1.75

S27. NON-EUCLIDEAN GEOMETRY, R. Bonola. Standard coverage, history, exposition, with complete texts of Bolyai & Lobatchevsky included. 180 diagrams. 431 pp. Paperbd. $1.95

S182. GEOMETRY OF FOUR DIMENSIONS, H. P. Manning. Unique in English, simple, easily followed account. 76 figures. 357 pp. Paperbound $1.95

S292-3. THEORY OF SOUND, Lord Rayleigh. Solutions for vibrating systems, hints on non-linears. Harmonic functions, theory of resonators, etc. Formerly $12. Total 1041 pp. 2 vol. set. Paperbound $3.90

S81. PRINCIPLE OF RELATIVITY. Einstein, Lorentz, Weyl, Minkowski. 11 papers founding relativity. Unabridged translations. "Indispensable," NATURE. 224 pp. Paperbound $1.65

S193. HIGHER MATH. FOR STUDENTS OF CHEMISTRY & PHYSICS, J. Mellor. Class favorite, unequalled review, practical rather than theoretical, on lab situations: Integral, differential calculus, theory of errors, etc. 662 pp. Paperbound $2.00

S346. ELEMENTS OF MATHEMATICAL BIOLOGY, A. Lotka. Classic application of math to biological sciences, "Vast amt. of facts unattainable within same compass elsewhere," NATURE. 72 figures. 490 pp. Paperbound $2.45

T394. FADS AND FALLACIES IN THE NAME OF SCIENCE, Martin Gardner. Enlarged revised edition of IN THE NAME OF SCIENCE, the standard coverage of the cults, fallacies, and curious systems that have recently masqueraded as science. It ranges from astronomy to theoretical physics, chemistry, geology, medicine, psychology, philosophy, history, scientific method. It is not a collection of anecdotes, but a fair, reasoned appraisal of eccentric theory. Flying saucers, Atlantis, General Semantics, dianetics, orgone energy, hollow earthism, Bridey Murphy—dozens of others are all treated. "Every scientist, for the preservation of his own good sense, should read this book," QUART. REV. OF BIOLOGY. "Hilariously entertaining," SAN FRANCISCO CHRONICLE. x + 365 pp. 5⅜ x 8. Paperbound $1.50

S267. SPACE TIME MATTER, H. Weyl. "Standard treatise on the general theory of relativity," NATURE. 348 pp. Paperbound $1.75

S298. FAMOUS PROBLEMS OF ELEMENTARY GEOMETRY, F. Klein. Squaring circle, doubling cube, pi, in terms of rigorous modern math. 103 pp. Paperbound $1.00

S342. INTRO. TO THEORY OF NUMBERS, L. Dickson. Nontechnical, wide coverage. 239 problems. 191 pp. Paperbound $1.65

T371. TRIGONOMETRY REFRESHER FOR TECHNICAL MEN, A. Kiaf. 913 detailed questions, answers brush up for you. 1738 problems. 436 pp. Paperbound $2.00

T370. CALCULUS REFRESHER FOR TECHNICAL MEN. A. Kiaf. 756 detailed questions, answers, in unique practical refresher. 566 problems. 436 pp. Paperbound $2.00

All books standard 5⅜" x 8" unless otherwise indicated.

Dept. 121, Dover Publications, Inc.
920 Broadway, N.Y. 10, N.Y.
Please send me the books encircled below: (Please print)

Name .....

Address .....

City ..... **Zone** .... **State** .....

I am enclosing $..... in full payment. (Payment in full must accompany all orders except those from libraries or public institutions, who may be billed.) Please add 10¢ postage per book on orders less than $5.00. Dover pays postage on orders of $5.00 or more.

T1	$27	$81	T97	$109
T110	$133	T143	T162	$164
T167	$182	$193	T198	T203
T264	T265	$267	$289	$292-3
T295	$298	T335	T337	$342
T344	$346	T361	T362	$366
T370	T371	$377	T384	T394
$413	T417			

Satisfaction guaranteed! All books may be returned within 10 days for full cash refund if they are unsatisfactory for any reason whatever.

...for sharp, clear waveforms

in physiological event monitoring

HERE is a high quality, easy to operate oscilloscope designed *especially* for visually monitoring physiologic waveforms in conjunction with Sanborn direct writing recording instruments. Waveform is presented as a sharp, distinct yellow trace on the Viso-Scope's double-coated 5″ diameter screen. Long image retention allows complete visual presentation of an event that lasts four seconds. Electrically analogous (in part) to a television receiver, the Viso-Scope is just as easy to operate: sweep speed (25, 50 and 100 mm/sec.) is selected by turning a knob . . . three other knobs control on-off and Scale Brightness, Focus, and Trace Brightness. These are the only controls needed for routine operation.

Usefulness of the Viso-Scope is further enhanced by: provision for enlarging the tracing at any time to a scale of 1″ deflection on scope for 1 cm. stylus deflection on chart; an illuminated reference scale on the screen, for estimating the size and duration of the trace; suitability to photography, with Dumont, Fairchild or other cameras; and use with other Sanborn instruments, such as the Model 179 Electronic Switch (shown below) for simultaneous presentation of as many as *four* waveforms, or with the Model 185 Vector Amplifier for vectorcardiography.

SANBORN
MODEL 169A
Viso-Scope

Detailed descriptive four-page folder, showing Viso-Scope uses with other Sanborn instruments, is available on request. Write to

SANBORN COMPANY
MEDICAL DIVISION
175 WYMAN ST., WALTHAM 54, MASS.

ASCO PRODUCTS DESIGNED FOR BETTER PERFORMANCE • LONGER LIFE

LABORATORY GLAND

24/40 – $11.75 ea. 34/45 – $14.75 ea.
29/42 – 13.50 ea. 45/50 – 17.50 ea.

TEFLON STD. TAPER STOPPERS

24/40 – $ 8.80 ea. 34/45 – $11.75 ea.
29/42 – 10.25 ea. 45/50 – 13.50 ea.

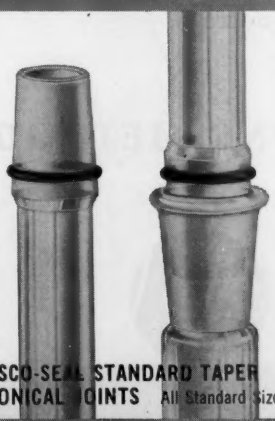
"QUORN" STD. TAPER SLEEVES

10/30 – $1.50	29/42 – $1.85	45/50 – $2.40
14/35 – 1.55	34/45 – 2.00	50/50 – 2.70
19/38 – 1.60	40/50 – 2.20	55/50 – 3.10
24/40 – 1.75		

THERMOCOUPLE VACUUM GAUGE
$90.00 complete

BATTERY-OPERATED THERMOCOUPLE VACUUM GAUGE
$90.00 complete

WATER-COOLED OIL DIFFUSION PUMP
$76.00 EA.



ASCO-SEAL STANDARD TAPER CONICAL JOINTS All Standard Sizes

ACCU-VAC ABSOLUTE VACUUM AND PRESSURE GAUGES

Model	Pres. Range	Each
A120	0-20mm. Hg.	$79.50
A140	0-40mm. Hg.	75.00
A160	0-760mm. Hg.	72.50

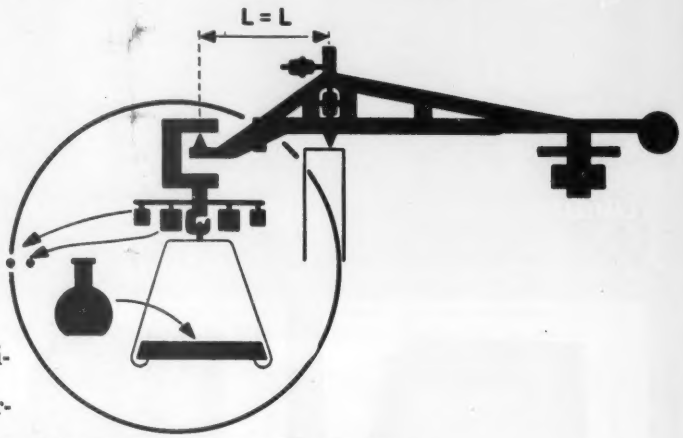
ENCLOSED McCLEOD GAUGE
$42.50 each

asco

For ordering, or further information, write: Dept. S927,

ARTHUR F. SMITH CO., 311 ALEXANDER ST., ROCHESTER 4, N. Y.

METTLER BALANCES ARE TRULY MODERN



WITH US IT'S A MATTER OF PRINCIPLE..

To weigh is to compare. The substitution balance makes this all-important comparison on one and the same beam arm. Errors due to arm-length variations are impossible in this system. They are present when sample and weights are compared on the opposite arms of an equal-arm, three knife-edge balance.

METTLER was the first one to build a modern substitution balance, combining the evident superiority of this principle with high speed and great ease of operation. METTLER is the only one to offer semi-micro and micro balances built on the same superior principle.

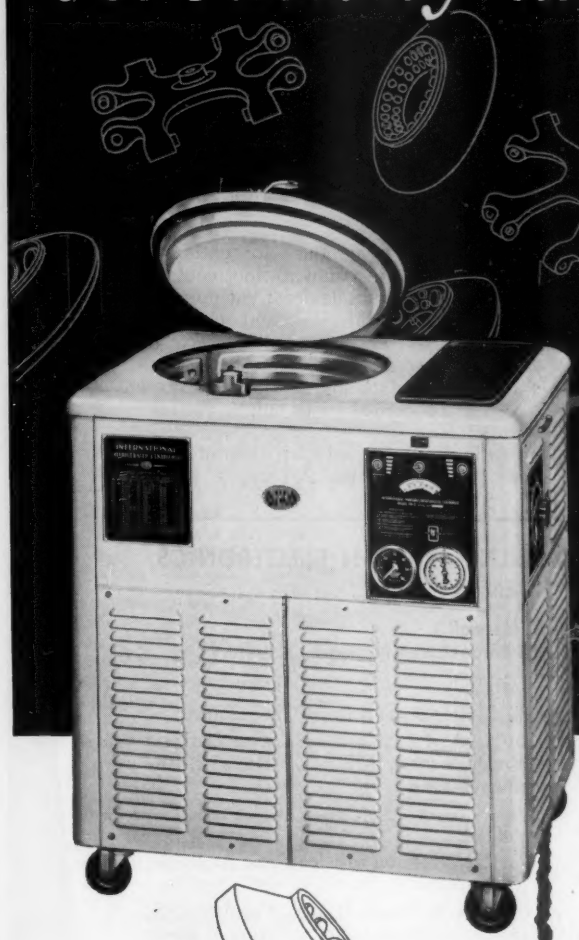
HOW MODERN ARE YOUR WEIGHING METHODS?

Are you working with balances which do not give you the safe assurance of accuracy that is inherent in the substitution principle?

Let us show you what METTLER balances can do for you. Write to us today for our complete file on METTLER balances.

METTLER
INSTRUMENT CORPORATION
HIGHTSTOWN, N. J.

versatility unmatched!



INTERNATIONAL REFRIGERATED CENTRIFUGE Model PR-2

Now recognized as a basic instrument in medical research, the refrigerated centrifuge is being called upon for wider and wider ranges of applications.

Here's how International's Refrigerated Centrifuge, Model PR-2 provides the scientist with *versatility unmatched* . . .

28 INTERCHANGEABLE HEADS, including a *new* SHAKER HEAD ATTACHMENT for shaking under controlled temperatures, 16 direct-drive angle heads, 7 direct-drive horizontal heads, 4 high-speed angle heads.

4 LITER CAPACITY right down to 7 ml., offers the greatest capacity range of any refrigerated centrifuge on the market today.

INTERNATIONAL'S PROGRAM of consistently designing new heads and accessories to meet the requirements of new techniques, guarantees the owner a refrigerated centrifuge of constantly increasing versatility.

Send for Bulletin P

International Equipment Co.

1284 SOLDIERS FIELD ROAD • BOSTON 35, MASSACHUSETTS

CVT COMMITTEE ON VACUUM TECHNIQUES

Symposium on Vacuum Technology

Edited by EDMOND S. PERRY and JOHN H. DURANT

This volume contains the complete proceedings of the Symposium on vacuum technology, sponsored by the Committee on Vacuum Techniques of Boston, Massachusetts. The forty papers presented cover fundamental development; methods and techniques for obtaining high vacuum; instrumentation; controls and other vacuum devices; vacuum distillation; metallurgical and chemical applications; and technical subjects of current interest. This book will serve as an up-to-date source of information to all concerned with high vacuum work.

Profusely illustrated with diagrams and photographic plates. 234 pages. $15.00

INTERNATIONAL SERIES OF MONOGRAPHS ON ELECTRONICS AND INSTRUMENTATION

General Editors: D. W. FRY, (A.E.R.E., Harwell), W. HIGGINBOTHAM (Brookhaven National Laboratory)

Vol. I.
Signal, Noise and Resolution in Nuclear Counter Amplifiers.
by A. B. GILLESPIE, A.E.R.E., Harwell. Illustrated. $4.50

Vol. II.
Scintillation Counters.
by J. B. BIRKS, B.A., Ph.D., D.Sc., F.Inst.P. Illustrated $4.50

Vol. III.
Probability and Information Theory with Applications to Radar.
by P. M. WOODWARD, R.R.E., Malvern. Illustrated. $5.00

Vol. IV.
Physics and Applications of Secondary Electron Emission.
by H. BRUINING, Eindhoven. 134 illustrations. $5.50

Vol. V.
Millimicrosecond Pulse Techniques.
by I. A. LEWIS, R.R.E., Malvern and F. H. WELLS, A.E.R.E., Harwell. 162 illustrations. $7.50

Vol. VI.
An Introduction to Electronic Analogue Computers.
by C. A. A. WASS, R.A.E., Farnborough. 150 illustrations. $6.50

Vol. VII.
Scattering and Diffraction of Radio Waves.
by J. R. MENTZER, Pennsylvania State University. 34 illustrations. $6.00

PERGAMON PRESS

NEW YORK	LONDON	PARIS	LOS ANGELES
122 East 55th Street, New York 22, N.Y.	4 & 5 Fitzroy Square, London, W.1.	24 Rue des Écoles, Paris Ve.	10638, South Wilton Place, Los Angeles 47, California

27 September 1957, Volume 126, Number 3274

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

LAURENCE H. SNYDER, *President*
WALLACE R. BRODE, *President Elect*
PAUL B. SEARS, *Retiring President*
PAUL M. GROSS
GEORGE R. HARRISON
PAUL E. KLOPSTEG
CHAUNCEY D. LEAKE
MARGARET MEAD
THOMAS PARK
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Executive Officer*

DAEL WOLFLE, *Executive Officer*
GRAHAM DUSHANE, *Editor*
CHARLOTTE V. MEETING, *Associate Editor*
JOSEPH TURNER, *Assistant Editor*

Editorial Board

WALLACE R. BRODE — EDWIN M. LERNER
BENTLEY GLASS — WILLIAM L. STRAUS, JR.
KARL LARK-HOROVITZ — EDWARD L. TATUM

Editorial Staff

PATRICIA L. CARSON, MARY L. CRABILL, HARRY DAVID, SARAH S. DEES, NANCY S. HAMILTON, OLIVER W. HEATWOLE, YUKIE KOZAI, ELLEN E. MURPHY, ROBERT V. ORMES, BETHSABE PEDERSEN, MADELINE SCHNEIDER, MARGO E. STOUT, JACQUELYN VOLLMER

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢. Single copies, 25¢. Special rates to members of the AAAS. Cable address: Advancesci, Washington.

Rates effective 1 January 1958: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 25¢.

Shifting the Burden

The determination of safe levels for food additives has engaged the attention of scientists since the turn of the century. The first food and drugs law, passed in 1906, marked a great step forward in reducing hazards to health by declaring that foods were adulterated if they contained any deleterious or poisonous substances in dangerous amounts. But the burden of proof lay on the Government, which had to show that a given food contained poisonous substances in sufficient amount to be a danger to health.

When properly used, food additives serve to improve the quality of food or to increase food production. In the first category are those additives that are used to improve storage qualities (antibiotics in chickens) or taste (artificial flavors) or texture (as in ice cream or bread) or appearance (artificial coloring) or convenience (as in cake mixtures). In the second category are those additives that get into food either unintentionally or unavoidably: residues from substances used to increase yields (fertilizers and pesticides) or from substances used in the treatment of diseases in food animals (penicillin in milk).

Subsequent to the 1906 law, the use of additives has been growing, but this growth cannot increase indefinitely. Although each food with its additive, if eaten separately, may be harmless, several foods eaten together may contain enough poisonous substances to be harmful. Consequently, the Federal Food, Drugs, and Cosmetics Act of 1938 attempted to control the use of additives by providing that no poisonous substance could be added except when it was required or could not be avoided in production or processing. In such cases the Government was authorized to set safe limits for the amount of the additive. But again the burden of proof lay on the Government. New and untested chemicals may be added to food without legislative hindrance. The Government's testing program lags far behind as the number of additives increases. Meanwhile, products may be sold and consumed. Fortunately, most food processors carefully test all additives, but some do not and none is required to.

In view of these circumstances, it is easy to understand why eight bills directed toward the control of additives were introduced during the last session of Congress and why these bills have been the subject of continuing hearings before the Subcommittee on Health and Science of the House Committee on Interstate and Foreign Commerce.

One of the bills, which is supported by the Administration, attempts to shift the burden of proof from the Government to the processor. It requires the processor to present scientific evidence that any new additive is safe. If testing shows that the substance may in certain concentrations act as a poison, the Government requires the processor to show that it has functional value, that is, that it serves a useful purpose, or is unavoidable in the process of manufacture. In this case, the Government would determine tolerance limits as it does at present for known poisonous substances and for pesticides.

From the evidence brought forward at the hearings so far it appears probable that the subcommittee will recommend a bill embodying some or all of the provisions of the Administration bill. It is unlikely that the views of the National Canners Association, which is ". . . adamantly opposed to having any Federal agency determine what the American consumer likes or dislikes, or what serves a useful purpose in any food . . ." will prevail.—G. DuS.

U-V

. . . harnessed to your research needs

Ultra-Violet microscopy is hastening major advances in cancer research, in living-cell studies, in all bio-chemistry. The B&L equipment shown here reveals differential absorption of biological materials at high numerical aperture—with twice the resolving power attainable in the visible portion of the spectrum. This complete, compact U-V laboratory (Grating Monochromator, U-V optics, Research Microscope, and Model L Photomicrographic Equipment) can be the practical solution to your research problem. May we demonstrate it for you?

Write for complete information, and for an obligation-free survey of your U-V requirements. Bausch & Lomb Optical Co., 64221 St. Paul Street, Rochester 2, N. Y.

27 September 1957, Volume 126, Number 3274 SCIENCE

Ethological Concepts

R. F. Ewer

Two publications dealing with theoretical aspects of animal behavior which are of considerable importance have appeared recently—the proceedings of the Josiah Macy Conference No. 1 on *Group Processes* and a paper by Prechtl (*1*) entitled "Neurophysiologische Mechanismen des formstarren Verhaltens." The Josiah Macy Conference served to bring together, in discussions, leaders of the European school of comparative ethology and American workers, who have in general been either very little influenced by, or highly critical of, the approach and ideas of ethologists. In this connection the papers given by Tinbergen (*2*) and Lorenz (*3*) are of most relevance. The discussions could hardly be expected to settle all outstanding problems, but they went far to make clear exactly where the divergences of opinion lie. Prechtl's paper, written independently of the conference, treats of a number of the same problems from a neurophysiological viewpoint. It is therefore convenient first to outline some of the problems that were raised at the conference and then to consider the bearing on certain of them of Prechtl's ideas.

There appear to be two main foci at which objections to the concepts of the ethologists converge: first, are the behavior patterns which they study really innate? and second, are they based on the accumulation of "action specific energy"?

Innate Behavior Patterns

The protagonists in the discussion of innate behavior patterns are Tinbergen and Lehrman. In the past, Tinbergen has tended to refer to an activity as an innate behavior pattern, without further ado, if it is characteristic of the species and does not require, for its manifestation, previous conditioning in the stimulus situation in which it does occur. At the other extreme, Lehrman (*4*) has emphasized that all behavior has an ontogeny and that, in this ontogeny, processes akin to learning may occur. This makes it difficult to decide on criteria of innateness, and ultimately Lehrman reaches the position of almost implying that there is no such thing as innate behavior. At the conference, Tinbergen was more guarded in his formulation and, acknowledging the justness of much of Lehrman's criticism, tended to avoid using the word *innate*.

It is true that the ontogeny of behavior is not only a legitimate but a very important study; it is true that *innate* may be the wrong word; but it is also true that anyone who has ever watched animals can hardly fail to be struck by the difference in the way in which, for example, a newborn kitten finds the maternal teat, and sucks, and the way the same kitten presently learns to come running to the kitchen the instant it hears the refrigerator door being opened. To say that "all behavior is to some extent learned" or that "no behavior is fully innate" does not advance us. The difference is real, and the point is to try to find out what is the essential nature of the difference. It seems best, even at the risk of appearing platitudinous, to try to look at the issue again from the very beginning, paying particular attention to Lehrman's insistence on the importance of ontogeny—an aspect that is stressed also by Beach (*5*) in his contribution to the Josiah Macy Conference.

Since an animal is an active metabolizing system, it must include, in its developmental make-up, regulatory mechanisms, many of them worked by the nervous system (such as regulation of respiration and of heartbeat) that keep it a metabolic going concern. These mechanisms are usually regarded as belonging to the domain of physiology, rather than behavior; physiology deals with internal regulation, behavior with relations with the environment, but the distinction, although it is often convenient, is largely artificial. Most animals do not live in a nutrient soup that is absorbed without the necessity of behavior. They must therefore include, in their developmental make-up, responses which insure that, shortly after birth or hatching, they do get food. These responses will count as behavior, but the responses of the gut muscles and glands to the food, once it is inside the animal, count as physiology.

As Pavlov pointed out long ago, unless an animal "has" a certain amount of behavior, there is and can be no basis on which learning can build. For a newborn mammal that has extensive parental care, the necessary behavioral equipment for beginning to live in the outside world is small. Apart from a response to the maternal teat, such behavioral equipment includes very little: possibly some form of vocalization in response to nocuous stimuli, such as being sat on by the mother, and some form of response to "danger" signals. In kittens it also includes a tendency to be at rest only when receiving stimuli provided by contact with litter-mates and, in ungulates, a following response.

These responses of the newborn are innate, in the strict sense of the word, but the point which is more important in the present context is that they are self-differentiating—that is, they come into being as part of the normal development of every individual; provided that the environment is not so inimical as grossly to interfere with development, they will be there. Haggling about the environment will not help us here; we cannot avoid it or remove it or see how an animal would develop without an environment, although the investigation of what constitutes a "normal" environment is as legitimate a study, in behavioral terms, as is a study of dietetic requirements in physiological terms. We might well remember Carlyle's comment on Margaret Fuller's declaration that she accepted the universe: "By gad! She'd better!" In this use of the term *self-dif-*

The author is a research worker in the department of zoology, Rhodes University, Grahamstown, Union of South Africa.

ferentiating, we assume that the environment permits of normal development.

As the animal grows, further self-differentiating responses become necessary; behavior which will permit it to become self-supporting must start to mature. (In an animal that is without parental care, such behavior will be present from the start, or at any rate from the time when egg food-reserves are used up.) This process will involve the development of locomotory behavior in a previous nest-dweller, and of responses to potential food or to "instructions" from the parent. It will probably also include some form of toilet behavior; in a nest-dweller that previously excreted in response to maternal stimulation, it will include behavior concerned with micturition and defecation, and it may include responses to "danger" signals. Once this basis has been laid, the animal can learn to the limit of its capacity, but unless there is self-differentiation of the basis on which to learn, the animal will die, or remain in permanent infantile dependency.

At the end of this stage, the animal will be self-supporting and may be capable of learning to support itself more and more effectively. All necessity for self-differentiating behavior is, however, not yet at an end. Reproduction as well as individual survival is necessary. Therefore, at some stage, which may be later, there must be self-differentiation of behavior concerned with reproduction (*6*). This may consist of highly specific responses to highly specific releasers and is likely to be of this type in a species where individuals live in isolation. In a communal species, less specificity is permissible; the essential minimum could theoretically be reduced to a mere shifting of "interest" (that is, a change in the times allotted to various activities) and readiness to learn the appropriate behavior patterns by imitation or instruction. Parental behavior is part of reproductive behavior, but it may develop a little later and may be conditional on the physiological changes which occur during the process of reproduction. Nevertheless, the conditions with respect to the degree of specificity of response necessary are the same as for sexual behavior.

All this may be summarized by saying that to think about innate or learned behavior in an abstract manner is unbiological and unprofitable. Behavior must be considered in terms of real, live animals, each with its own particular mode of life. It then becomes obvious that, while it would be theoretically possible to have an animal all of whose behavior was self-differentiating, it would be quite impossible to have one without a basis of such behavior. The nature and extent of the self-differentiating basis, however, vary from group to group, always in a manner that is correlated with mode of life. Factors which make for the presence of highly complex and highly specific self-differentiating patterns will be lack of parental care, short duration of life, and solitariness of the individual, and, conversely, self-differentiating patterns may be reduced where there is parental care, longevity, and communal life.

Advantages of Present Approach

This approach has certain advantages:

1) It avoids all the confusion caused by the word *innate,* with its connotation of "present at birth." Birth is not the only nodal point in development, and it is therefore undesirable to use a term that focuses attention on this particular developmental step. A life-history may, but does not have to, include the following three stages: infancy under parental care, individual independence, and the adult reproductive phase; further nodal points may be present in cases where larvae have a mode of life different from that of adults.

2) It clarifies the distinction between a rigidly stereotyped "species specific pattern" (which may be essential in a short-lived, solitary creature without parental care) and, at the other extreme, a mere redirection of interest, which could be all that is required to insure successful reproduction in a highly social species.

3) It emphasizes the fact that a self-differentiating piece of behavior includes the phase during which it is in the process of differentiating; this makes it easier to understand that processes akin to learning can be an integral part of the differentiating process. On the sensory side we have imprinting, and, on the motor side, there is frequently a phase in which coordination improves with practice and the component parts of a total pattern become more effectively integrated. As examples, one may cite (i) "learning to walk," in kittens or babies; here the locomotory pattern is self-differentiating but involves increasingly improved coordination; (ii) micturitional behavior in kittens; here the scratching pattern is at first very imperfectly coordinated with the place at which urine is voided, but coordination develops gradually. Although maturation is undoubtedly important in such cases, it appears rarely to account for the whole of the improvement; for example, puppies which have been prevented from walking, although they catch up with their normal litter-mates quite soon after the removal of restraint, are at first inferior in coordination.

4) It adds to an understanding of the interaction of various factors in selection. Two examples will illustrate this: (i) We know that, in mammals, complex species-specific patterns are less important than in lower invertebrates. This is clearly secondary; the development of parental care permits the loss of the specificity of pattern and the build-up of learning ability. That learning "goes with" parental care is obvious; the point is that parental care not only provides opportunities for learning but also makes possible the remodeling of the whole basis on which the learning is built. (ii) In social insects, learning by experience and by tuition is poorly developed, despite the presence of two of the factors which are conducive to reduction in stereotyped, specific patterns. This appears to be the result of central nervous conservatism. Before these animals became social they were already insects—a complex and highly evolved group in which the trend has been toward perfection and elaboration of the specific patterns. The adoption of social habits did not result in a reversal of this trend, already well advanced, but in an elaboration of patterns and development of releasers concerned with social activities other than reproductive ones (for example, dancing, in bees).

Thus it seems that a strong case can be made for abandoning the term *innate* and replacing it with *self-differentiating* or with something similar (and preferably shorter). *Autonomous, autogenous,* and *endogenous* are all possibilities. Of these, my preference is for endogenous, and the phrase *endogenous behavior patterns* could be substituted for *innate behavior patterns* without great increase in cumbersomeness. A piece of behavior will be judged to be endogenous if it (i) is shown at the appropriate stage, in the appropriate situation, by all members (or all members of one sex) of a species and if it (ii) has not required either "instruction" from another member of the species or previous conditioning by means of an externally provided reward or punishment which does not form an essential component of an environment that permits of normal physical development.

This last formulation is intended to allow for the fact that the process of differentiation of an endogenous pattern may include the type of learning that was referred to in paragraph 3 of this section. Here, the reward, if any, is internal to the animal and consists of attaining the consummatory state of having performed the pattern adequately. If such performance does act as a reward, this itself is part of the animal's make-up; the situation is not identical with an externally imposed reward or punishment. In the latter case, the stimulus results from the operation of factors

outside and independent of the animal, and its presence or absence is controlled by these external factors; in the former, the reward is included in, and inseparable from, the healthy animal itself. Precisely because it is internal, this sort of reward can become an integral part of the way in which an endogenous mechanism does differentiate. One will, of course, expect to find differentiation involving this type of learning only in cases where it does not matter if first attempts are imperfect. A kitten or a baby, protected by its mother, can afford to "learn to walk," but a baby whale must be able to swim very soon after birth. A tomcat can learn to copulate, but a male spider has to get his mating pattern right the first time or his mate may eat him.

We are now in a position to consider a problem that was posed by Beach (*5*) at the Josiah Macy Conference. Grooming is an activity that is normally performed by all chimpanzees and appears to be an innate pattern. However, if a young chimpanzee has its hands and feet enclosed in boxes which prevent it from touching its own body, it will not groom when the restraint is later removed. Grooming, therefore, appears to be learned—but, as Lorenz pertinently remarked, "has it not learnt to groom, or has it learnt not to groom?" If we abandon the false antinomy of *innate* versus *learned,* it is clear that grooming is, by the criteria that I have given, an endogenous pattern. The fact that some form of learning may be involved does not affect the issue; that particular learning has involved only other parts of the single differentiating system that constitutes the organism and is independent of instruction or of external reward or punishment. The experiment is not meaningless, although the question it set out to answer may be; the question it does answer is not about how to classify the behavior but about the factors that are involved in the differentiation of this particular pattern.

It is clear that the criteria that I have given for endogenous patterns are virtually the same as those that Tinbergen uses for innate behavior patterns. It therefore looks rather as though we had just come 'round in a big circle and got back to our starting point. This is true, insofar as we end by agreeing that the category of behavior studied by ethologists is a real category. But it is also true that, by turning from *innate* to *endogenous,* we have shifted our emphasis from the time at which a piece of behavior occurs (which may not be very meaningful) and have focused it instead on how that behavior comes into being. I believe that this shifting of viewpoint, while it results in agreement with the ethologists that we were really looking at something all the time, allows us to see a little more clearly what it was we were looking at and a little more of its relationship to other phenomena. If this is so, then the change is worth making.

Accumulation of Action-Specific Energy

In the case of "innate behavior" the problems are largely those of definition, and, although we remain largely ignorant of the neural basis of patterned behavior, considerable clarification of our ideas appears possible, along the lines that have been indicated. With "action-specific energy," however, we are dealing directly with the question of the neural basis of the type of behavior that is studied by the ethologists. Our ignorance of central nervous function seems to preclude any immediate solution, but consideration of what the difficulties are does permit some tentative ideas about where their solutions may lie and what sort of experiments might be expected to be of value.

Lorenz has been mainly responsible for emphasizing the differences between reflexes and endogenous behavior patterns. The basic difference is that a reflex is a response to a detectable stimulus whereas, with endogenous patterns, there appears to be a spontaneous accumulation of something which facilitates the response and which is dissipated by the performance of the appropriate behavior pattern. Normally, the response will be made in the presence of a releasing stimulus, but even in the absence of any such stimuli, a vacuum response may be made. A second difference between reflexes and endogenous patterns is the fact that appetitive behavior is characteristically associated with the latter but not with the former. Lorenz was himself originally a reflexologist, but his own observations forced on him the recognition of these differences; to describe them, the expression *accumulation of action-specific energy* was devised. Concentration on the differences, which was very necessary at first, gradually resulted in a viewpoint that implies an essentially dualistic mode of action of the central nervous system. On the one hand were reflexes, explicable in terms of the known physiological properties of nerve axons, cells, and junctions; on the other was something different, involving the phenomena of accumulation and dissipation of action-specific energy and not explicable in the same terms. Needless to say, this attitude was repugnant to physiologists, who, although they would readily agree that the brain is more complex than the spinal cord, are not willing to believe that its functions are not based on physiolcgically similar processes. The objections to such physiological dualism are well summarized by Kennedy (*7*).

Such dualism becomes unnecessary if it can be shown that the phenomena studied by the ethologists can be accommodated within the framework of known neurophysiological processes. Prechtl's paper (*1*) is an attempt to show how modern developments in neurophysiology offer the possibility of such a reconciliation and unification.

It will be convenient to deal first with the minor point—the linkage of appetitive behavior with endogenous patterns but not with reflexes. Since this difference concerns only the connections to other neural mechanisms of the centers that are responsible for the two types of behavior, it does not necessarily imply any fundamental difference in the physiology of the centers themselves. Prechtl points out that the functional significance of the difference is clear enough. Reflexes deal, on the one hand, with internal regulation of function and, on the other, with protective responses to potentially nocuous stimuli. In the first case, appetitive behavior is unnecessary, since the stimulus is generated inside the animal; in the second, it is undesirable. In endogenous patterns, appetitive behavior is essential; food, a mate, a suitable nesting site or the like may not be met with in its absence. The case of breathing, discussed by Spurway and Haldane (*8*), is an example of a reflex center which does have an appetitive component (albeit a vestigial one, in land mammals), showing clearly that it is functional, not physiological, criteria which determine the presence or absence of an appetitive component.

Some Possible Mechanisms

The more fundamental difference—the spontaneity of the endogenous pattern in contrast with the stimulated reflex response—must now be considered. In the Josiah Macy Conference, Lorenz quotes observations which make it clear that it would be impossible to explain the type of behavior which he is studying in terms which do not involve the accumulation of something, somewhere inside the animal. His examples of vacuum activities are particularly cogent. Since this is the case, the first point to be considered is, "What is accumulating, and where?" Differential effects are involved, since an animal may be in a state of readiness to perform one particular pattern but not another.

There are two ways in which this might be achieved (one has a chemical, the other a topographical, basis): (i) Production of diverse excitatory substances anywhere in the body and their

accumulation in the blood. Each center must be assumed to be specifically sensitive to its own particular excitant; the nature of the excitant produced therefore determines what center is activated and, consequently, what behavior results; (ii) production and accumulation of an excitatory substance within the centers themselves. Only a single substance has to be invoked, since the activation of one center rather than another depends on the locus in which the excitant is being accumulated.

The ethologists have favored the second view: the hydraulic analogy of Lorenz (*9*) implies that the "excitatory fluid" accumulates within a particular instinctive center and is drained from it in the discharge of the activity that is characteristic of the center. The latter is thus seen as being largely autonomous and as spontaneously generating its own excitation. No neurophysiological analysis of an instinctive center has, as yet, been made, but such studies have been carried out on a number of centrally initiated internal regulatory mechanisms. In each case, the regulation has been found to be of reflex type and to depend on the presence of intracentral receptors. For example, the automatism of the medullary respiratory center depends on the presence of cells that show the normal properties of receptor cells, which are specifically sensitive to carbon dioxide (*10*). In the absence of carbon dioxide, the receptors are unstimulated, and the apparent spontaneity of the center disappears. Similarly, there are osmosensitive structures in the anterior hypothalamus (*11*) and heat-sensitive cells, also in the hypothalamus (*12*), that are responsible, respectively, for the initiation of responses dealing with the regulation of blood concentration and body temperature. These particular automatisms thus work on the basis of alternative i in the preceding paragraph—differential sensitivity of the centers (based on specific receptor-type cells) to differences in blood characteristics.

The suggestion that the instinctive centers of the ethologists are also activated, by way of specific intracentral receptors, by substances that are circulating in the blood is an obvious one. Certainly, substances that are circulating in the blood do affect them, as is evidenced by the onset of sexual behavior after hormone injection or by the effects of fluid depletion on drinking, and so forth. The postulation of other types of intracentral receptors might suffice to account for the initiation of endogenous behavior patterns; the difficulty arises when we consider what turns them off. In the case of the afore-mentioned physiological regulations, the answer is simple. The act itself sets in train a series of events which results in abolishing or reducing the intensity of the stimulus to the intracentral receptors. In breathing, the muscle contractions initiated by the respiratory center start a series of events, each one of which is well understood, which finally results in reduction of the carbon dioxide concentration of the blood.

For endogenous patterns, however, an answer in these terms alone cannot be the correct one, since an activity may cease regardless of whether or not it has attained its biological end, as in the gaping of nestling birds. Inhibitory feedback is the obvious candidate for the role of "turner-off"; but it is clear that the feedback that is responsible for the cessation of a behavior pattern cannot originate in the muscles involved. The same muscles are used in one pattern after another and cannot, therefore, provide the necessary specificity. Muscular feedback is concerned with the regulation of movement, as such—with insuring that the correct movement is made, regardless of whether the animal is heavy or light, the ground rough or smooth, the starting point with the weight on this foot or that, and so forth—and not with the major patterns into which the movements are integrated. Of course, specific peripheral feedback can exist in certain cases—stimuli from contact with the eggs are specific to the activity of brooding, and stimuli from the penis, to copulation. In such cases, peripheral feedback may be important, but it is totally inadequate to account for all cases.

This point is stressed by Lorenz (*3*), and cases of independence of peripheral afferent control are quoted by him. Of these, the most striking is the vacuum occurrence of the whole complex sequence of movements involved in the binding of a length of grass into its nest by a weaverbird that had no nesting material available—a bird, in one instance, that had never even seen a blade of grass in its life. In this case, afferent feedback of any specific type is out of the question.

Here Prechtl again has some important suggestions. He points out that peripheral feedback is not the only known source of inhibitory influences and suggests that more attention be given to inhibition arising within the central nervous system. A considerable amount of information already exists both about specific inhibitory pathways emanating from the cortex and more generalized ones from the reticular formation. An instinctive center could turn itself off by activating a pathway to a specific inhibitory center, which would then relay back and inhibit the original center. One must assume either a high threshold for the pathway to the inhibitory center or, more probably, that it is opened only by the performance of the closing phases of the specific activity of the center concerned; a parallel with the "off effects" that originate in the sensory pathways at once suggests itself (*13*). A hypothesis of this type is (in theory at least) experimentally verifiable. If the location of a center is known, then the effects of operative elimination or stimulation of pathways which might possibly be inhibitory may be studied.

Consideration of the central interconnections of the relevant center may also provide the answer to another of the problems raised by Lorenz (*3*)—namely, the nature of internal reward. In nest building, correct performance seems to be its own reward, and this is of importance in some species in learning to select the right type of material, in others, in learning where to build. How does it happen that correct performance does act as a reward, to reinforce itself? Some experiments of Olds (*14*) on rats, and of Sidman *et al.* (*15*) on rats and cats, may provide an answer. Certain regions have been located in the septal area, lateral amygdala, and anterior hypothalamus whose stimulation can be used as a reward in training experiments; moreover, if given the opportunity to stimulate themselves by pressing a lever, the animals will do so with great frequency. Here, then, are brain areas whose stimulation is sought by the animals, and this stimulation can function as a reward in learning. If such a center acts as a relay station between an instinctive center and an inhibitory center, turning off the activity after correct performance, then we have the necessary condition for correct performance acting as reward. The animal may be expected to learn the correct performance, as the rats learned to reward themselves by pressing the stimulating lever.

Although a reflex interpretation of the action of instinctive centers, as has been outlined, thus seems possible, this is not necessarily the only possible explanation in terms of known physiological processes. Other rhythmically active systems are known, which function in a nonreflex manner, and these must also be considered. Although, in the vertebrates, there is no unequivocal evidence for the existence of spontaneous, centrally initiated rhythms, there are indications that these may exist in invertebrates. Von Holst (*16*) recorded a spontaneous central rhythm that corresponded to the normal locomotory rhythm in the isolated nerve cord of the earthworm, and Wells (*17*) has shown that the rhythm that governs the irrigation cycle in *Arenicola* also originates in the nerve cord. Peripheral automatisms are also known, both in vertebrates and in invertebrates; the vertebrate heart and gut muscles provide examples, and the esophageal pacemaker system that is responsible for initiating the feeding cycle in *Arenicola* (*17*) appears to be very similar. The exact

method by which the activity is initiated may vary in different cases, but whether it depends on two sorts of cell, one producing an excitant, the other responding to it, or on a single cell type producing its own excitant does not affect the conclusion that there do exist systems which are rhythmically active without external excitation, either in the form of nervous input or alterations in blood composition.

Seeking New Evidence

It is thus clear that no new type of nerve function has to be postulated to account for the action of the centers that are responsible for endogenous behavior patterns. Our present knowledge of neurophysiology is sufficient to provide two possible models, the one depending on reflex excitation by way of intracentral receptors, the other on locally produced excitants. The difficulty is to devise experiments that will enable us to decide between the two possibilities. The difficulty arises from the fact that, even if they are basically self-excitatory, the centers that are concerned with endogenous patterns must be subject to some modulating influences exerted by blood composition serving to correlate and integrate their activities. One might, for instance, be tempted to conclude that if vacuum sexual activities never occur in a castrated animal, then there can be no autoexcitant production in the relevant centers. This does not follow, since clearly there would have been selection, in the past, to limit the production of any such autoexcitant to a level which remains subliminal in the absence of the appropriate hormone; otherwise the animal will waste its energies in behavior which is inappropriate, or which it is incapable of carrying to its functional conclusion.

A direct attack, by excising centers and finding out whether an excitant is extractable from a center that was just about to discharge at the moment of death but not from one which was not ready to react, is feasible but has not yet been attempted. In view of the variety of substances that are extractable from the central nervous system, this is probably a type of experiment in which the chance of getting a meaningful answer is small.

A second method of investigation lies in further exploitation of the technique of stimulation of brain centers with implanted electrodes. With this technique it has already been possible to locate areas whose stimulation results in the performance of normal patterns of behavior. A full "mapping" of any one species would make it possible to study such things as the variations in threshold, in relation to previous activity, of any particular center, the effects on it of removal of its connections with other areas, or the effects of simultaneous stimulation of other centers or of alterations in blood composition, to name only the most obvious possibilities. Until such investigations have been made, it is premature to assume that the types of behavior that are studied by the ethologists cannot be based on the same sort of nervous functioning that simpler reflex forms of behavior are based on, or to abandon the view that the complexities of the central nervous system are based on complexities of arrangement and interconnection. At the same time, it must be recognized that, although the idea of centers' generating their own excitation may not be attractive to physiologists, autoexciting systems are not unknown in their own domain of physiology. The fact that, in vertebrates, such systems have been clearly demonstrated only in peripheral organs like heart and gut does not prove that they cannot exist within the central nervous system.

It is unfortunate that the use by ethologists of such descriptive expressions as "accumulation of action-specific energy" has, in the past, tended to repel physiologists and conceal from them the fact that the work of the ethologists has brought to light phenomena of extreme importance for the understanding of behavior—phenomena which demand analysis not only on their own level, by the methods of ethology, but simultaneously by physiological techniques. Prechtl concludes his paper by expressing the hope that it will not only serve to bring to the notice of ethologists some of the more recent developments in neurophysiology but will also draw to the physiologists' attention problems raised by ethology which only physiological techniques can solve. "'Tis a consummation devoutly to be wished." (*18*).

References and Notes

1. H. F. R. Prechtl, *Behaviour* 9, 243 (1956).
2. N. Tinbergen, in *Group Processes*. First Josiah Macy Conference (Josiah Macy, Jr., Foundation, New York, 1955), pp. 75–167.
3. K. Lorenz, *ibid.*, pp. 168–220.
4. D. S. Lehrman, *Quart. Rev. Biol.* 28, 337 (1953).
5. F. A. Beach, in *Group Processes*. First Josiah Macy Conference (Josiah Macy, Jr., Foundation, New York, 1955), pp. 9–74.
6. Although sexual behavior is not normally shown until the onset of sexual maturity, the neural basis for the behavior is developed well in advance, and sexual behavior may be evoked precociously in an immature animal by hormone injection.
7. J. S. Kennedy, *Brit. J. Animal Behaviour* 2, 12 (1954).
8. H. Spurway and J. B. S. Haldane, *Behaviour* 6, 8 (1953).
9. K. Lorenz, *Symposia Soc. Exptl. Biol.* 4, 221 (1950).
10. H. von Euler and U. Söderberg, *J. Physiol. (London)* 118, 545, 555 (1952).
11. E. B. Verney, *Proc. Roy. Soc. (London)* B135, 25 (1947); P. A. Jewell and E. B. Verney, *Trans. Roy. Soc. (London)* 240, 197 (1957).
12. S. W. Ranson, *Research Publs. Assoc. Research Nervous Mental Disease* 20, 342 (1940).
13. R. Granit, *Receptors and Sensory Perception* (Yale Univ. Press, New Haven, Conn., 1955).
14. J. Olds, *Science* 122, 878 (1955).
15. M. Sidman *et al.*, *ibid.* 122, 830 (1955).
16. E. von Holst, *Naturwissenschaften* 25, 625, 641 (1937).
17. G. P. Wells, *Symposia Soc. Exptl. Biol.* 4, 127 (1950).

18. I am indebted to the South African Council for Industrial Research for a research grant.

W. C. Mendenhall, Geologist

Walter Curran Mendenhall devoted his life to service in the U.S. Government. It appears that even when he was attending college at Ohio Normal University (now Ohio Northern University) he was attracted to geology and, after his first field work with the U.S. Geological Survey, decided to make a career in that organization. Except for several short absences—a year at Harvard University and another at Heidelberg—he was employed continuously on the survey from 1894 until his retirement in 1943. During those 49 years, he rose from geologic aide to assistant geologist, to geologist, to chief of section, to chief of two branches (now divisions), and to director.

His first assignment to field work was with M. R. Campbell in studies of Appalachian coal fields in West Virginia, Tennessee, and Kentucky during 1895, 1896, and 1897. Following this, he was one of the small group who did pioneer exploration in Alaska, during four seasons between 1896 and 1902, with a diversion for one season in the Cascade Range with G. O. Smith. Those not familiar with frontier conditions, especially as they existed in Alaska 60 years ago,

find it almost impossible to understand the physical difficulties involved in geologic work. In the early days, traverses were made on foot or in canoes along the principal streams, and mental vigor had to be maintained in the face of constant hard labor. The work in Alaska yielded 12 reports and short papers. In his summary of geologic work in Alaska in 1906, Alfred H. Brooks, then chief of the Alaskan Branch, pays tribute to Mendenhall's work.

His next assignment was the study of ground-water conditions and problems in southern California, first in the basins south of the San Gabriel and San Bernardino Mountains, then in the Mojave Desert, and then in the San Joaquin Valley. This work continued from 1903 to 1909 and yielded 12 reports and related papers. The records of this work are still essential background in the present water problems in those regions.

From 1908 until his retirement in 1943, Mendenhall held administrative assignments in Washington headquarters, first in charge of ground-water investigations, then as chairman of the Land Classification Board (later the Conservation Branch), which must classify all public lands and approve assignment of those lands to private owners. This extended from 1911 until 1922, when he was appointed chief geologist, to succeed David White. When George Otis Smith, the director of the survey, was appointed to the Federal Power Commission in 1930, Mendenhall became acting director, until 1931, when he was confirmed as director. He retired in March 1943 at the age of 72. For the next 15 years he lived quietly at his home in Chevy Chase, Maryland, playing golf, reading, and seeing his friends. In 1926 the honorary degree of Sc.D. was conferred on him by the Colorado School of Mines; in 1932 the same degree was conferred on him by the University of Wisconsin, and in 1944 he was awarded the Penrose medal of the Society of Economic Geologists.

Most of those who have served in scientific bureaus in the Government think that those who are appointed to high administrative status should have demonstrated capacity in scientific work. It is natural, therefore, that his superiors should have turned to Mendenhall, with his early splendid record in geologic field work and his demonstrated capacity as an adviser and critic in field problems, for administrative duties. That he continued in this work for the rest of his life may be explained by his high sense of duty in the execution of assigned tasks and by his feeling of loyalty to the organization. In the great growth of the survey during the war years, it was Mendenhall's chief concern that standards in men and workmanship be maintained at high level.

It may be possible to understand much of Mendenhall's life by recalling some of the influences of his ancestry, youth, and early environment. He was born in Ohio of Quaker parents in 1871, and, until he went to college, he lived on a farm under the influence of the simple forms of Quaker life. Even though in his later life he ceased to maintain contacts with the sect, much of their attitude toward life and daily demeanor had been impressed upon him. With his mother, as long as she lived, he used the forms of speech of the Quakers. In his contacts during his mature life he was friendly but reticent, more inclined to listen than to speak, and rarely speaking of his inner thoughts. Even as chief geologist and director he disliked speaking in public. In the science of geology, where progress depends on myriad observations and on thought and discussion, Mendenhall approved of discussion but disliked arguments. Quite unemotional himself, he was suspicious of fervor. Many who knew him well agree that one of his outstanding qualities was integrity in thought and action, and none who knew him ever suspected him of having a selfish purpose.

"His was a proud spirit but proud of simplicity, proud of integrity, proud of genuineness and independence and tolerance, never of place or power or trappings; and proud of reputation only as evidence that his own well-based but unassertive self-respect found support in the opinions of men." These words were written by Mendenhall in 1935 in the memorial that he prepared on the life and work of David White. The ways in which men describe their associates also reveal much of their own aspirations, understanding, and sense of values. Those who knew Mendenhall intimately agree that this description of David White reveals much of his own character, motives, and demeanor.

D. F. HEWETT

U.S. Geological Survey, Menlo Park, California

R. S. Lull, Vertebrate Paleontologist

For many years, one of the most popular lecturers in science at Yale University was Richard Swann Lull, who is remembered with respect and affection by the thousands of students who took his course on organic evolution. Tall, straight, impressive in appearance, he was a gifted speaker, with unusual ability to dramatize his subject.

Lull was born at Annapolis, Maryland, on 6 November 1867, the son of Captain Edward Phelps Lull of the United States Navy, one of the original explorers of the interoceanic canal routes in Central America, and Elisabeth Burton Lull. Since his youthful ambition to follow a naval career was thwarted by deafness, he entered Rutgers University, in 1888, where he played rugby football, set a record with the 16-pound shot, and won the Suydam national science prize and sophomore oratory medal. In 1893 he received his B.S. degree in zoology and, in 1895, the M.S. degree. He accepted an assistant professorship in zoology at Massachusetts State Agricultural College (Amherst) in 1893 and there commenced his studies of the Triassic reptile footprints in the collection of nearby Amherst College. In 1903 he received his Ph.D. from Columbia University and, in 1906, came to Yale as assistant professor of paleontology and associate curator of the Peabody Museum of Natural History. He was Sterling professor of vertebrate paleontology from 1922 until his retirement, in 1936. From 1922 until 1938 he was director of the Peabody Museum and, from 1933 until 1949, editor of the *American Journal of Science.*

Dinosaurs constituted Lull's main scientific interest. He completed the monograph on the Ceratopsia, or horned dinosaurs, which had been commenced by O. C. Marsh and J. B. Hatcher, and later published a revision. He monographed the duck-billed dinosaurs and wrote many shorter reports on dinosaurs. Other large vertebrates also claimed his attention—elephants and mammoths, whose evolution he summar-

ized in detail, and whales, whose adaptation to aquatic life formed a major chapter in his text on evolution. The evolution of the horse and of ancient man were also the subjects of important books and papers from his pen.

Fossil footprints were of particular interest to him because they were records of living animals. His dissertation on Triassic footprints was expanded into a comprehensive study of the Triassic life of the Connecticut Valley, which was revised and republished shortly before his death.

In his later years, some of his most popular lectures were accounts of experiences on the American Museum of Natural History expeditions to Wyoming, in 1899, and to Montana, in 1902; on these he helped collect the *Brontosaurus* skeleton that is now mounted in New York and various *Triceratops* skulls. Fossil collecting in those days involved slow travel, by horse team, and camping in remote spots for weeks at a time, quite unlike conditions under which paleontologists work today. After coming to Yale, Lull organized collecting expeditions to Nebraska, Wyoming, and Texas, which brought back a variety of fossil mammals to enrich the collections of the Peabody Museum.

His carefully organized lectures on organic evolution were published in 1917 in a textbook of that title, which was widely used for many years. He wrote many popular articles about evolution, paleontology, and fossil collecting, contributing toward understanding of science.

Rutgers conferred an honorary D.Sc. degree upon him in 1915. In 1933 he received the Daniel Giraud Elliot medal of the National Academy of Sciences for his memoir on Ceratopsia. Lull belonged to many scientific and honor societies; in 1925 he was president of the Paleontological Society.

Failing eyesight compelled him to relinquish his research in 1955, and he died on 22 April 1957, in his 90th year.

JOSEPH T. GREGORY
Peabody Museum, Yale University, New Haven, Connecticut

News of Science

Trough in Ocean Bottom

The Coast and Geodetic Survey has announced the discovery of a deep, long crack in the bottom of the Gulf of Alaska that may cause major tidal waves.

The crack, which is 500 to 700 feet below the ocean floor and probably 2 to 3 miles wide, stretches in a southwesterly direction across much of the gulf below southern Alaska. It is known to be at least 250 miles long, and may possibly be 400.

The existence of the trough has been suspected for many years as a result of scattered depth soundings in the area. Its presence has now been confirmed by soundings obtained by survey ships as they crisscrossed the gulf between the Bering Sea and the Aleutian Islands.

In the last 40 years, 37 seismic sea waves have been recorded in the Pacific, 16 of them since 1950. One of the most destructive hit the Hawaiian Islands in 1946. The discovery of the trough may help the Coast and Geodetic Survey to improve its detection and warning system for tidal waves in the Pacific Ocean.

Revised Curriculum at Harvard

Approximately 230 first- and second-year students in the Harvard Medical School, and 29 students in the Harvard School of Dental Medicine, will this year start upon a revised curriculum in the preclinical sciences. The new curriculum stresses interdepartmental teaching, broadens the tutorial system, and increases the amount of unscheduled time available to the students. It retains the current emphasis on the study of the normal body and biological processes in the first year, then shifts to studies of disease states in the second year. The program also preserves the research time available to members of the faculty of medicine. Much of the revised preclinical curriculum derives from observations of the operation of a unified teaching program in the basic medical sciences that was established in 1952 in the Division of Medical Sciences of the Graduate School of Arts and Sciences.

Idaho Reactor

The Atomic Energy Commission will conduct an industrial preview 2–3 Oct. of its Engineering Test Reactor (ETR) at the National Reactor Testing Station, Idaho Falls, Idaho. The program will include a day-long symposium on the reactor's design, construction costs, experimental facilities, and operation. Approximately 250 representatives of U.S. industries concerned with building and employing nuclear test and research reactors for civilian and industrial use have been invited to participate. They will be joined by members of Congress, the Atomic Energy Commission, and the press.

The ETR will provide the highest neutron flux of any known reactor and the largest spaces within an enriched uranium core for determining the effects of intense neutron and gamma-ray bombardment on engineered components and materials to be used in nuclear power plants and nuclear propulsion units for aircraft and ships.

The primary ETR facilities were designed and constructed by Kaiser Engineers Division of Henry J. Kaiser Company; they will be operated for the commission by Phillips Petroleum Company. General Electric Company designed the reactor, the core, and the controls. The cost of the reactor is about $14 million. Other experimental facilities and equipment associated with the reactor will cost an additional $2 million.

USDA Research Facilities for Conservation

The U.S. Department of Agriculture has announced that funds have been made available by the Congress to provide new Federal research facilities in various areas of the country for work on problems of soil and water conservation and for pilot-plant study of new wool-processing methods. New laboratories for soil and water conservation research will be located at Oxford, Miss.; Watkinsville, Ga.; Phoenix, Ariz.; and Morris, Minn. A pilot plant for wool research will be established at Albany, Calif. The facilities for soils research will be operated by the Soil and Water Conservation Research Division, and the wool pilot plant will be operated by the Western Utilization Research and Development Division, both of USDA's Agricultural Research Service.

Associate Editor Resigns

We regret to announce the resignation of Charlotte V. Meeting from her position as associate editor of *Science* and *The Scientific Monthly*. As associate editor, Miss Meeting played a central role in the production of the magazines; she will be greatly missed by the editorial staff. She and her husband, Leonard Gregory Phillips, who are currently traveling in Europe, will establish a permanent residence at 225 Carlisle Blvd., SE, Albuquerque, N.M., after 15 Dec.

—G. DuS.

October Scientific Monthly

Articles appearing in the October issue of *The Scientific Monthly* are "Controlling the digital computer," R. W. Hamming; "Ovigenic-ovisorptive cycle in the economy of the honey bee," S. E. Flanders; "Karst landscapes of Cuba, Puerto Rico, and Jamaica," A. H. Doerr and D. R. Hoy; "Concept of energy in mechanics," R. B. Lindsay; "Control of screw-worm fly by atomic radiation," E. F. Knipling. Fifteen books are reviewed.

News Briefs

Atomic Energy and Agriculture, publication No. 49 of the AAAS, was released this month. This 460-page volume, which was edited by C. L. Comar of the Oak Ridge Institute of Nuclear Studies, contains 22 papers by 32 authors. It may be obtained from the association's headquarters in Washington, D.C.

* * *

The National Science Foundation has announced that 462 grants totaling $6,190,601 were awarded during the quarter, which ended on 31 July. These awards were for the support of basic research in the sciences, for conferences in support of science, for short-term research by medical science students, for exchange of scientific information, and for training of science teachers.

* * *

The first nuclear reactor for the Far East, located near Tokyo, began operating on 27 Aug. Atomics International, a division of North American Aviation, Inc., designed and built the solution-type, 50-kilowatt research reactor for the Japan Atomic Energy Research Institute.

* * *

A model of a coelacanth has been placed on exhibit at the Smithsonian Institution, Washington, D.C. Like the one recently anounced by the American Museum of Natural History in New York, the Smithsonian's model was prepared in Paris under the supervision of Jacques Millot, director of the Scientific Institute of Madagascar.

* * *

The University of Michigan will dedicate its new Automotive and Aeronautical Engineering Laboratories on 15 Oct. "Transportation and its technology" will be the theme of the dedication ceremonies, at which C. C. Furnas, chancellor of the University of Buffalo, will deliver the chief address.

* * *

The World Health Organization has announced publication of the report of the Study Group on the Effect of Radiation on Human Heredity. A complementary publication entitled *"Challenge of atomic energy"* has also been released by WHO in its monthly journal, *Chronicle of the World Health Organization.* This special issue contains a summary of the report and working papers of the study group.

* * *

Nuclear Metals, Inc., has announced the successful conclusion of its transition from a Government-owned atomic energy research facility to complete private ownership and operation, thus making the personnel and facilities of the laboratory available to industry on a consulting basis. Equipment that has just been purchased from the Government will be moved to new laboratory buildings under construction by Nuclear Metals in Concord, Mass. At present the company is operating in two of the Government's buildings in Cambridge, Mass.

* * *

Scientific organizations and industrial firms last fiscal year purchased 240,240 copies of Government technical research reports through the Office of Technical Services, U.S. Department of Commerce. This is 58,131 copies more than the 1956 total, or an increase of approximately 33 percent.

Scientists in the News

WILLIAM H. CHARCH, director of the Pioneering Research Division, Textile Fibers Department, E. I. du Pont de Nemours and Company, has been awarded the Chandler medal by Columbia University in recognition of his outstanding achievements in the industrial development of moisture-proof cellophane and of synthetic fibers.

W. H. VAN DEN BOS, head of the Union Observatory near Johannesburg, South Africa, has retired after 26 years of service. He is succeeded by W. S. FINSEN, who first joined the laboratory staff in 1924 at the age of 17.

Van den Bos built up an exhaustive card catalog of all observations and measurements of visual double stars south of 19 degrees south. He discovered nearly 3000 new double stars himself and today is an outstanding specialist in this subject.

ALLISON BUTTS, who retired last year as head of the department of metallurgy at Lehigh University, has gone to Turkey on a mission for the United Nations Educational, Scientific, and Cultural Organization under the U.N. technical assistance program. He will work with Technical University of Istanbul in developing materials testing laboratories for the newly created Institute of Materials and Production Methods that has been set up by the university's faculty of mechanical engineering.

BERNARD KERN, associate professor in the physics department, University of Kentucky, is on leave of absence from the university to work with the physics staff of the U.S. Naval Radiological Defense Laboratory in San Francisco, Calif.

Recent Deaths

RICHARD G. AUSPITZER, Lawrence, N.Y.; 71; consulting engineer; brought the Schloetter nickel-plating process to the U.S.; 9 Sept.

ARTHUR H. BARNES, Chicago, Ill.; 53; director of the reactor engineering division of the Argonne National Laboratory, Lemont, Ill.; developed a direct-current electromagnetic pump; 8 Sept.

MARION A. BLANKENHORN, Cincinnati, Ohio; 61; former chairman of the department of internal medicine at the University of Cincinnati; specialist in pellegra and aviation medicine; 3 Sept.

LEON C. DARRAH, Reading, Pa.; 67; obstetrician; founder of the American Academy of Obstetrics and Gynecology; 7 Sept.

JOHN M. HIGH, Croton-on-Hudson, N.Y.; 57; electronics engineer and inventor; held 17 basic patents in electronics; 5 Sept.

SAMUEL KLEINBERG, New York, N.Y.; 71; orthopedic surgeon and specialist in scoliosis; 6 Sept.

FRANK O. NAGLE, Philadelphia, Pa.; 73; professor emeritus of ophthalmology at Hahnemann Medical College; maintained private practice in ophthalmology for 40 years; 9 Sept.

WILLIAM C. SANDY, Geneva, N.Y.; 80; psychiatrist and director of the Bureau of Mental Health, Pennsylvania Department of Welfare; former associate editor of the *American Journal of Psychiatry* and a past president of the American Psychiatric Association; 7 Sept.

RALPH O. SMITH, Salem, N.J.; 76; chemist and head of the Gayner Glass Works laboratory; 7 Sept.

Reports

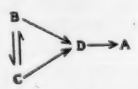
Paper Chromatography of Unstable Substances

Many organic substances are extremely unstable in solutions (sometimes also in the solid or liquid state) and are usually available only in mixture with a variable proportion of their decomposition products. Moreover, the more unstable ones go on decomposing during chemical operations and particularly during the procedure of paper chromatography. The result is that, where one spot only is expected, several may appear—an effect which is particularly troublesome in two-dimensional chromatography.

In studies of the decomposition products of indole derivatives, some of which are particularly unstable, in collaboration with Alexandra P. Nogueira, we have employed to advantage two-dimensional chromatography in which the same solvent is used in both directions (*1*). For this method, we suggest the name *double chromatography* to distinguish it from ordinary two-dimensional chromatography, in which two different solvents are used in succession.

The method can be extended to stable products which can be induced to decompose by physical means, such as exposure of the chromatogram to ultraviolet radiation before or after the first chromatography, or both.

The double chromatogram to be expected of a mixture of four substances, *A*, *B*, *C*, and *D*, decomposing according to the scheme



is shown in Fig. 1. Substances *B* and *C* are tautomers, or a monomer and its dimer, and, when separated from mixtures in which they are in equilibrium, they produce a quantity of the other substance until equilibrium is again attained. Substance *D* is a decomposition product of both *B* and *C*, and *A* is a decomposition product of *D*. Figure 1 shows that if decomposition takes place in between the first and the second chromatography, two spots of *B* and of *C*, three of *D*, and four of *A* are to be expected.

During the first chromatography, the four substances already in the mixture applied at the origin distribute themselves according to their R_f values, as is shown in Fig. 1 by interrupted circles. Since the same solvent is used in the second direction, these spots (primary spots) will appear accurately centered on the diagonal of the chromatogram after its completion. All spots appearing above or below the diagonal correspond to substances which have been produced between the first and the second chromatography and are therefore secondary spots. The tautomers *B* and *C* have produced secondary spots of each other and secondary spots of *D* and *A*. *D* has produced a secondary spot of *A*. The different spots of one substance are all equally displaced in the second dimension and are therefore aligned at the corresponding R_f (vertically in Fig. 1). The secondary spots of the decomposition products of each substance and the primary spot of the substance itself are horizontally aligned.

When comparatively large quantities of material are applied to the chromatogram, "trails" appear, which are troublesome in one- and two-dimensional chromatograms, but which in the case of double chromatograms actually furnish further evidence of the decomposition pathway of the products applied at the origin. They have been shown as interrupted lines in the diagram of Fig. 1.

Each vertical trail corresponds to a single decomposition product produced during the first chromatography. It crosses the diagonal exactly at the primary spot of that product and extends above and below the diagonal to the R_f values of its precursors. When there is one precursor only, the trail is entirely above or below the diagonal.

Horizontal trails are made up of the decomposition products of the substance at the corresponding R_f and cross the diagonal at the primary spot of that substance.

In some of our chromatograms, we have found a trail along part of the diagonal. This trail is difficult to interpret but may be evidence of polymerization of one of the substances, the spots of the monomer, dimer, and so forth, centering on the diagonal line and more or less merging into one another.

In practice, the diagonal is usually not a straight line, because the rate of flow of the solvent is not strictly the same in the first and the second chromatography; the R_f values are accordingly a little different in each direction.

As a rule, not all the spots or trails are visible, because of the small amounts of the decomposition products. Total decomposition may entirely suppress some of the primary spots, but their location is accurately determined at the crossing of the horizontal trail of their decomposition products and the diagonal. Faint or doubtful spots may be identified by their position on the diagonal and in the trails. Composite spots containing more than one substance or made up of the primary and secondary spots of the same substance can be interpreted on the same basis. The easy identification of spots and trails allows the application on double chromatograms of considerably greater amounts of the sample than in one- or two-dimensional chromatograms.

Figure 2 shows the outline of spots of a double chromatogram of indolepyruvic acid (IPyA) (*2*) after the first chromatography (*A*) and after the second chromatography (*B*). The small chromato-

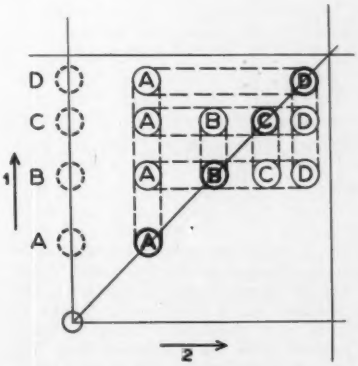


Fig. 1. Theoretical distribution of spots and "trails" of unstable substances in a two-dimensional chromatogram using the same solvent in both directions. Substances *B* and *C* are spots of tautomers which decompose into both *D* and *A* in succession. The distribution of spots after the first chromatography is shown in interrupted circles.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

gram (10- by 10-cm usable surface) was prepared, according to the ascending method used by us (*3*) with water as the solvent, in an atmosphere saturated with vapors of acetic acid. The numbers correspond to substances which have been identified by their spots in chromatograms and characterized by physical and chemical properties of the spots or their eluates (*3*). The diagonal has been traced as a curved line, the curving resulting from the accumulation of a substance in the filter paper at the front line of the first chromatography. This substance, which is not entirely removed by repeated washing of the filter paper, slows down the flow of the solvent during the second chromatography. Two horizontal rows of decomposition products at R_f values 0.14 and 0.71 are seen on the chromatogram. They cross the diagonal line at primary spots 2 and 4.

On the basis of this and other chromatograms, as well as on the basis of physical and chemical properties of the eluates, these spots are interpreted as corresponding to the keto and the enol forms of indolepyruvic acid. A secondary spot of substance 4 appears in the trail of substance 2, and vice versa. Secondary spots of substances 1, 8, 6, 7, and 5 appear on the horizontal trails of both 2 and 4 and correspond to decomposition products of these substances. Secondary spot 1*a* appears in the trail of substance 4 only, and secondary spot 3 in that of substance 2 only. Only one vertical trail, that of substance 1, has been traced, because the others were faint and because the chromatogram was made at a time when their significance was not yet well understood. Composite spots such as the cluster near the primary spot of substance 4 and the large spot of substance 8 have been interpreted according to their position in relation to the diagonal and the horizontal rows of spots as well as to their fluorescent colors.

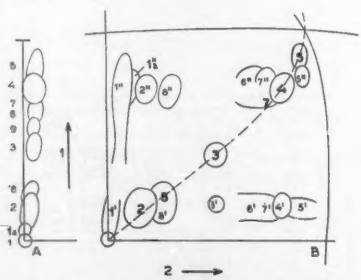


Fig. 2. Double chromatogram of approximately 50 μg of indolepyruvic acid. Water was used as solvent in both directions. The container was saturated with vapors of acetic acid. Ascending chromatography. Primary spots are distributed along the curved diagonal line. Secondary spots marked with a prime sign are from the decomposition products of substance 2, and those marked with a double prime sign are from the decomposition products of substance 4. The keto and the enol forms of indolepyruvic acid have produced, respectively, the lower and the upper row of spots of decomposition products.

KÄTHE SCHWARZ*
A. A. BITANCOURT
Plant Cancer Research Center,
Instituto Biológico, São Paulo, Brazil

References and Notes

1. This work has been supported in part by grants from the Brazilian Research Council (CNP_q) and the Rockefeller Foundation.
2. The sample of indolepyruvic acid was kindly supplied by K. V. Thimann.
3. K. Schwarz, A. P. Nogueira, A. A. Bitancourt, "Spontaneous decomposition of some indole derivatives," in preparation.

* Research fellow, CNP_q.

6 May 1957

Effect of Cyanide on Biosynthesis of Ascorbic Acid in vitro

It was observed in this laboratory that when rat liver tissue, homogenized in a Potter-Elvehjem homogenizer with 0.25*M* sucrose, was incubated with certain compounds under suitable conditions, an increase in the ascorbic acid value occurred over that obtained without the added substrate, the ascorbic acid being measured titrimetrically with 2,6-dichlorophenol indophenol. It was, however, noticed that in no case could a net positive synthesis of ascorbic acid be attained; that is to say, the ascorbic acid content after incubation never exceeded that present in the tissue before incubation.

In the search for a means of developing a system in which a net positive synthesis could be realized, it has been found that when rat liver homogenate is incubated with D-glucuronolactone in the presence of potassium cyanide ($5 \times 10^{-2}M$), the ascorbic acid value obtained after incubation is markedly greater than that obtained without the added substrate; the value can, in fact, be 2 to 3 times the original tissue content of ascorbic acid. Without cyanide, no increase in ascorbic acid value has been observed (Table 1). Also, when the concentration of cyanide is below $5 \times 10^{-3}M$, the influence of cyanide on the synthesis is practically nil. On the other hand, an increase in the cyanide concentration above $5 \times 10^{-3}M$ steadily increases the synthesis until a concentration of $5 \times 10^{-2}M$ is reached, when no further enhancement of the synthesis of ascorbic acid is observed. This increase in the ascorbic acid value under the influence of cyanide is not revealed when sodium D-glucuronate is substituted for D-glucuronolactone. Boiled tissue extracts give no positive results under these conditions.

Hassan and Lehninger (*1*) have shown that the enzyme system concerned in this synthesis resides in the supernatant fluid after sedimentation of the nuclear fraction and mitochondria. The aforesaid capacity of liver homogenate to convert D-glucuronolactone into ascorbic acid in the presence of cyanide has also been found to be present almost entirely in this fluid, obtained according to the method of Hogeboom *et al.* (*2*). This synthesis under the influence of cyanide is not further enhanced by the addition of cofactors like diphosphopyridine nucleotide (0.0016*M*), adenosine triphosphate (0.0016*M*), and magnesium chloride (0.004*M*), either separately or conjointly.

The results obtained with cyanide appear, however, to be at variance with those reported by Hassan and Lehninger (*1*), who observed an *inhibition* of the synthesis of ascorbic acid in the presence of 0.01*M* cyanide, although they observed none with $5 \times 10^{-4}M$ cyanide. In a repetition of their experiments it has been observed that, in their system, in which adenosine triphosphate and other cofactors are used, a small increase in ascorbic acid of the order of 0.17 to 0.23 μm is obtained with both the lactone and the sodium salt of glucuronic acid. Even in this system, however, the addition of cyanide ($5 \times 10^{-2}M$) has been found to increase the synthesis to 0.30 to 0.35 μm of ascorbic acid, and this again with the lactone as substrate and not with sodium glucuronate. It is possible that, for the formation of ascor-

Table 1. The effect of potassium cyanide on the *in vitro* synthesis of ascorbic acid. The test system contains: 0.06*M* phosphate buffer (*p*H 7.0); 0.025*M* substrate; tissue concentration 50 mg (or its equivalent of supernatant fluid) per milliliter of incubation mixture; KCN 0.05*M*. Total volume is 5.0 ml, incubated at 37.5°C for 2 hours. Negative figures indicate loss of ascorbic acid on incubation.

Expt.	Substrate	Ascorbic acid (μm) synthesized	
		Without KCN	With KCN
Rat liver homogenate	None	−0.22	0
	D-Glucuronate	−0.24	0
	D-Glucuronolactone	−0.24	+0.77
Rat liver extract (supernatant fluid)	None	−0.20	0
	D-Glucuronate	−0.20	0
	D-Glucuronolactone	−0.20	+0.61

Table 2. The effect of cyanide on the *in vitro* synthesis of "total" ascorbic acid. The conditions are the same as in Table 1, except that the concentration of glucuronolactone was $0.0125M$. In determining "total" ascorbic acid, the metaphosphoric acid extract of the tissue was diluted sufficiently to avoid interference by cyanide, the final cyanide concentration of the diluted extract being $4 \times 10^{-3}M$.

Expt.	Substrate	Ascorbic acid (μm) synthesized	
		Without KCN	With KCN
Rat liver homogenate	None	0	0
	D-Glucuronate	0	0
	D-Glucuronolactone	0	+0.58
Rat liver extract (supernatant fluid)	None	0	0
	D-Glucuronate	0	0
	D-Glucuronolactone	0	+0.31

bic acid, the lactone structure is necessary and that cyanide prevents lactonization of glucuronic acid in the system studied. This might explain the difference in the behavior of the acid and of the lactone in this regard. In looking for the cause of the inhibition by cyanide observed by Hassan and Lehninger (*1*), it has been found that the method of Roe and Kuether (*3*), which was used by them for the determination of "total" ascorbic acid, would give low values for ascorbic acid in the presence of $0.01M$ cyanide. Thus, in a recovery experiment starting with pure L-ascorbic acid, it has been found that in the presence of $0.01M$ cyanide, only 2 to 3 μg out of 27 μg could be estimated by that method, while the ascorbic acid could be correctly estimated in the presence of $5 \times 10^{-4}M$ cyanide.

In order to throw further light on this question, estimations were also made of the "total" ascorbic acid in the present set of experiments (*4*) by Roe and Kuether's method. Without KCN, original values of ascorbic acid could be obtained after the period of incubation. But in experiments involving the use of KCN, the "total" ascorbic acid values, as estimated by that method, were lower than those obtained with the indophenol indicator. Nevertheless, these values were higher than the original values for "total" ascorbic acid in these tissues, showing a net positive synthesis of ascorbic acid from D-glucuronolactone in the presence of cyanide (Table 2).

That cyanide in the afore-described experiments actually facilitates the biosynthesis of ascorbic acid and does not merely act as a stabilizer has been confirmed by experiments in which it has been found that KCN at a concentration of $1 \times 10^{-3}M$ can completely protect (i) pure ascorbic acid, (ii) the ascorbic acid in the tissue, and (iii) pure ascorbic acid added to the tissue, whereas at this concentration no biosynthesis of ascorbic acid is observed. Biosynthesis is brought about only by KCN concentration above $5 \times 10^{-3}M$, as was mentioned before. It appears possible that the biosynthesis of ascorbic acid from D-glucurono-γ-lactone is catalyzed by an enzyme system which is activated by cyanide, or that cyanide acts by blocking an alternative pathway of the metabolism of glucurone which might involve an iron-containing enzyme system, or that there is a combination of these actions.

Livers from other species were also examined for their ability to convert D-glucuronolactone under the influence of cyanide. The results show that there is a considerable difference in the ability of different species to effect this synthesis, as is determined by indophenol titration. Goat liver appears to be the most potent among the mammalian livers examined, while the livers of the guinea pig, the chick, and the pigeon appear to be incapable of effecting this conversion under the experimental conditions studied. An enzyme concentrate which brings about the synthesis of ascorbic acid from glucurone in the presence of cyanide has been prepared from goat liver (*5*).

I. B. Chatterjee, N. C. Ghosh
J. J. Ghosh, B. C. Guha
Department of Applied Chemistry, University College of Science and Technology, Calcutta, India

References and Notes

1. M. ul Hassan and A. L. Lehninger, *J. Biol. Chem.* **223**, 123 (1956).
2. G. H. Hogeboom, W. C. Schneider, G. E. Pallade, *ibid.* **172**, 619 (1948).
3. J. H. Roe and C. A. Kuether, *ibid.* **147**, 399 (1943).
4. This work was supported by financial assistance from the Indian Council of Medical Research.
5. A detailed report is in preparation.

10 July 1957

Composition of the Placental Septa as Shown by Nuclear Sexing

The composition and source of the septa placentae, the thin membrane situated between the cotyledons of the human placenta (Fig. 1), have long been argued. Opinions have until now been varied on whether the cells comprising this tissue were of fetal or maternal origin. Grosser (*1*) discussed the then prevalent opinions and his own observations and expressed the view that the septum is composed of maternal tissue with a minor element of trophoblastic

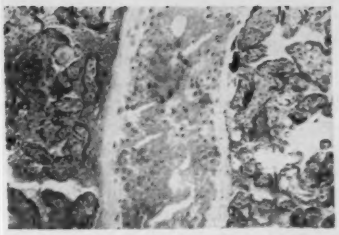


Fig. 1. Photomicrograph of a placental septum as it lies between adjacent cotyledons (×140).

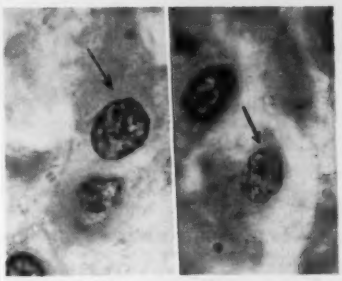


Fig. 2 (*a* and *b*). The same preparation as in Fig. 1, showing the cells of the septum under higher magnification (×1500). The arrows point to the sex chromatin bodies seen in the nuclei of these cells (Feulgen stain).

cells. Recent studies (*2*), including those of Wislocki, in which histochemical and electron microscopic methods were used, seemed to show that the septum was composed mainly of trophoblastic cells, with perhaps a small maternal element at its basal end. Other recent works (*3*), however, have still maintained that the structure is a maternal one.

A study of the placental septa in the human being has been carried out by us, the method being based on the morphological sex difference now known to exist in the nuclei of intermitotic cells (*4, 5*). It has been shown that this method is applicable to a variety of mammalian, and to most human, tissues, including embryonic tissues (*6*). The material used included placentas from 14 male fetuses at term, sections being cut at 6 μ, stained by the Feulgen method (Fig. 2), and examined at a magnification of times 1200. A count was made on 100 cells in each case, by two independent observers.

In ten cases, the percentage of cells with sex chromatin in their nuclei was well above 50 percent, and in another four cases, the proportion was more than 35 percent. In no case was the count within the limits of a male picture (male fetal tissues have been shown to contain a mean 12 percent sex chromatin bodies, *4, 7*). Studies performed on various female tissues in the human being have shown that the percentage of nuclei

showing the presence of sex chromatin varies according to the type of tissue examined. Ranges vary from 52 to 85 percent, in skin biopsies, to as low as 20 to 64 percent for exfoliated cells. Embryonic tissue (amniotic fluid cells) has shown a range of 34 to 66 percent (*4, 7*). In view of these observations, we feel that the results obtained in the present investigation allow us to suggest that the placental septa are composed for the most part of cells which are of maternal origin (*8*).

ARYEH SADOVSKY
DAVID M. SERR
GERTRUDE KOHN
Rothschild-Hadassah University Hospital and *Hormone Research Laboratory, Hebrew University Hadassah Medical School, Jerusalem, Israel*

References and Notes

1. O. Grosser, *Frühentwicklung, Eihautbildung und Placentation des Menschen und der Säugetiere* (Bergmann, Munich, Germany, 1927), p. 373.
2. G. B. Wislocki, *Anat. Record* 109, 359 (1951); H. Stieve and I. von der Heide, *Anat. Anz.* 92, 1 (1941) and in *Gestation* (Josiah Macy, Jr., Foundation, 1956), p. 140–143; N. J. Eastman, *William's Obstetrics* (Appleton-Century-Crofts, New York, ed. 11, 1956).
3. J. P. Greenhill, *Obstetrics* (Saunders, Philadelphia, Pa., ed. 11, 1955), p. 38; A. E. Petchenko, *Obstetrics* (U.S.S.R. State Publication, Kiev, 1956), p. 59.
4. K. L. Moore, M. A. Graham, M. L. Barr, *Surg. Gynecol. Obstet.* 96, 641 (1953).
5. K. L. Moore and M. L. Barr, *Acta Anat.* 21, 197 (1954); J. L. Emery and M. McMillan, *J. Pathol. Bacteriol.* 68, 17 (1954); K. L. Moore and M. L. Barr, *Lancet* 269, 57 (1955); E. Marberger, R. A. Boccabella, W. O. Nelson, *Proc. Soc. Exptl. Biol. Med.* 89, 488 (1955) and *Lancet* 269, 654 (1955); B. Lennox, *Scot. Med. J.* 1, 97 (1956).
6. M. A. Graham, *Anat. Record* 4, 469 (1954); E. Marberger and W. O. Nelson, *Bruns' Beitr. klin. Chir.* 190, 103 (1955); D. M. Serr, L. Sachs, M. Danon, *Bull. Research Council Israel* 5B, 137 (1955).
7. W. F. Hunter and B. Lennox, *Lancet* 2, 633 (1954); K. L. Moore and M. L. Barr, *ibid.* 2, 57 (1955); K. L. Moore and M. L. Barr, *Brit. J. Cancer* 9, 246 (1955); A. D. Dixon and J. B. D. Tarr, *Brit. Med. J.* 2, 799 (1956); L. Sachs, D. M. Serr, M. Danon, *ibid.* 2, 795 (1956).
8. Details of an extended study of this problem are in preparation. We are indebted to B. Zondek for his interest during the course of this study and for facilities provided in his laboratory.

19 July 1957

Stimulant Effect of 2-Dimethylaminoethanol—Possible Precursor of Brain Acetylcholine

Pfeiffer and Jenney (*1*) have found that the tertiary amines arecoline, pilocarpine, and eserine will inhibit the conditioned avoidance response in rats protected peripherally with atropine methyl nitrate. Arecoline, when used in atropine methyl nitrate-protected schizophrenic patients, will produce a "lucid interval" similar to that of amobarbital or carbon dioxide (*1, 2*). These findings initiated a new research program (*3*) designed to find longer acting parasympathomimetic agents or precursors of acetylcholine which might affect the central nervous system. Two quaternary nitrogen compounds, acetylcholine and methacholine, probably owing to their slow transit across the blood-brain-barrier, are without effect on the conditioned avoidance response. Furthermore, Mayer and Bain (*4*) have used the tertiary and quaternary analogs of a convulsant, fluorescent acridone, to delineate the blood-brain-barrier, and Koelle and Steiner (*5*) find that the quaternary nitrogen analog of a phosphate ester of thio-choline inhibits the peripheral but not the cerebral cholinesterase, while the tertiary amine congenor inhibits both. These observations are not compatible with the concept that choline acts as an effective precursor of cerebral acetylcholine, because choline may be limited in its transport across the membranal barriers.

The lack of pharmacological potency of choline chloride in man is evidenced in the treatment of patients with liver disease, where as much as 10 g per day may be given without any discernible acetylcholinelike pharmacodynamic effect (*6*). Since choline is a methyl donor, one might expect the tertiary analog to be readily formed *in vivo*. However, choline as a methyl donor has been reported to go to dimethyl glycine by way of the intermediate, betaine (*7*), and, therefore, it may not provide a tertiary amine precursor for the synthesis of cerebral acetylcholine. For this reason, possible tertiary amine precursors of acetylcholine, including 2-dimethylaminoethanol (DMAE), have been studied extensively in mammals, including man, in these laboratories.

The pertinent publications on DMAE can be summarized briefly as follows: Krayer *et al.* (*8*) find that DMAE in a dose of 200 mg/800 ml volume counteracts the cardiac failure produced by pentobarbital sodium. Biochemical studies [Korey *et al.* (*9*)] indicate that DMAE is acetylated at the same rate as is choline by choline acetylase, and that acetyl-DMAE has less than 0.01 of the activity of acetylcholine on the frog rectus preparation. In chronic feeding experiments on growing chicks on a choline-deficient diet, Jukes and Oleson (*10*) report that DMAE will partially substitute for choline. In a *Neurospora* cholineless mutant, however, Jukes and Dornbush (*11*) show that DMAE substitutes completely for choline as a growth factor. Reid (*12*), working with choline-deficient guinea pigs, finds that DMAE will substitute completely for choline, whereas aminoethanol, N-methylaminoethanol, betaine, dimethyl glycine, and methionine are ineffective.

The following pharmacological observations have been made (*13*). The oral

Table 1. Effect of choline and DMAE on convulsant thresholds when 1.0 g per day is given orally for 2 weeks. Twelve mice were used in each group, and 0.5 percent pentylenetetrazol was infused intravenously at the rate of 0.05 ml/10 sec. $t = 2.392$ for difference between means of choline and DMAE. $p = < 0.05$.

Treatment	Lethal convulsion (ml/mouse)
Controls	0.457 ± 0.11
Choline	0.433 ± 0.09
DMAE	0.342 ± 0.11

LD_{50} of DMAE tartrate is 3.1 ± 0.16 g/kg, mouse, and 2.6 ± 0.1 g/kg, rat. With these large doses, animals show respiratory depression and frequently die of pulmonary edema. In pharmacodynamic studies on anesthetized dogs, DMAE tartrate has approximately 0.002 of the vasodepressor effect of acteylcholine, 0.1 of that of pilocarpine, and 0.5 of that of choline chloride. The muscarinic effect on the guinea pig uterus is approximately 0.1 and on the rabbit ileum, 0.025 of that of choline chloride (*13*). Rats and other species tolerate and grow normally on daily doses of 50 or 100 mg/kg for 6 months or longer. Higher doses (500 mg/kg a day) produce a small but statistically significant lowering of the hematocrit, hemoglobin, and eosinophil count. The animals grow normally, but occasional deaths occur from maximal seizures which appear in both rats and mice after 3 to 4 weeks of dosage. Mice treated chronically at 500 mg/kg a day are also more susceptible to audiogenic seizures (*13*). Daily oral dosage of DMAE significantly lowers the threshold for seizures from intravenously infused pentylenetetrazol (Tables 1 and 2). These data correlate with those obtained in curarized nonanesthetized cats, in which DMAE demonstrated some antagonism of the effects of pentobarbital on the electroencephalogram. The incidence of low-voltage fast activity in the electroencephalogram, similar to that obtained during arousal, was increased

Table 2. Effect of choline and DMAE on convulsant thresholds when they are fed to mice as a 0.03*M* solution in drinking water for 31 days. Ten mice were used in each group, and 0.5 percent pentylenetetrazol was infused intravenously at the rate of 0.05 ml/10 sec. $t = 5.3295$ for difference between means of choline and DMAE. $p = < 0.001$.

Treatment	Lethal convulsion (ml/mouse)
Controls	0.525 ± 0.09
Choline	0.525 ± 0.10
DMAE	0.250 ± 0.11

by DMAE, and the threshold at which reticular stimulation induced this type of cortical activity was lowered (*13*). In standardized tests of emotionality, mice on DMAE 0.05 percent in drinking water (*ad libitum*) showed an increase in emotionality which was significantly different from the control mice. Maze learning of rats and mice on DMAE is not facilitated (*13*).

In rats and dogs, DMAE in doses up to 7.5 mg/kg does not produce an antidiuretic effect or a change in renal hemodynamics (*13*). Single doses of 500 mg/kg of DMAE do not protect mice from lethal doses of *d*-tubocurarine, decamethonium, atropine, or hexobarbital.

Since DMAE may occur in natural foods and may regulate the synthesis of acetylcholine, the cautious clinical trial of various salts of DMAE was initiated. Total oral doses as low as 10 to 20 mg of DMAE base per day produce, in 7 to 10 days, a mild and pleasant degree of central nervous system stimulation which is characterized by lessened daytime fatigue and sounder sleep, but fewer hours of sleep are needed. Doses above 20 mg/day may result in increased muscle tone (most evident in the neck, masseter, and quadriceps muscles) and insomnia. (This observation contrasts sharply with that for choline, where 10 g per day is devoid of stimulant action.) Our initial trial of DMAE in schizophrenic patients was at a dose level of 250 mg per day. These patients showed increased motor and verbal activity and insomnia. After 4 weeks the daily dose was reduced to 50 mg per day because of weight loss in the 12 male patients (average 5-lb loss), although urine and blood studies disclosed no abnormality. Since then, 40 to 50 patients have been on therapy for 1 year, during which time the laboratory findings have been within normal limits (*13*). The possible beneficial effect of DMAE therapy in the chronic schizophrenic patient is a gradual one and requires 6 months or more of therapy. We postulate that DMAE therapy can be made more effective in the chronic schizophrenic when biochemical adjuvants are found which will increase acetylcholine synthesis.

In patients other than schizophrenic, DMAE produces relief of periodic headache, functional bowel distress, and chronic fatigue syndromes. DMAE therapy has not made asthmatic patients worse and has not precipitated peptic ulcer symptoms but has slightly increased the incidence of grand mal seizures in two epileptic patients. The incidence of petit mal seizures is, in contrast, diminished by DMAE therapy. The central nervous system stimulation which occurs in man is not accompanied by a rise in blood pressure, a rise in body temperature, or a change in the plasma level of protein-bound iodine. Pharmacological and biochemical studies designed to elucidate the exact mechanisms of action of DMAE are now in progress.

CARL C. PFEIFFER
ELIZABETH H. JENNEY
WILLIAM GALLAGHER
Department of Pharmacology, Emory University, Georgia and *Manteno State Hospital, Manteno, Illinois*
RICHARD P. SMITH
WILLIAM BEVAN, JR.
Department of Psychology, Emory University
KEITH F. KILLAM
EVA KING KILLAM
Departments of Pharmacology and *Anatomy, University of California, Los Angeles*
WILLIAM BLACKMORE
Department of Pharmacology, Southwestern Medical School, University of Texas, Dallas

References and Notes

1. C. C. Pfeiffer and E. H. Jenney, *Ann. N.Y. Acad. Sci.* 66, 755 (1957).
2. J. H. Fulcher, W. H. Gallagher, C. C. Pfeiffer, *Am. Med. Assoc. Arch. Neurol Psychiat.*, in press.
3. This research was supported in part by Riker Laboratories, Inc., Los Angeles, Calif., and by the Geschickter Fund for Medical Research, Washington, D.C.
4. S. E. Mayer and J. A. Bain, *J. Pharmacol. Exptl. Therap.* 118, 1, 17 (1956).
5. G. B. Koelle and E. C. Steiner, *ibid.* 118, 420 (1956).
6. L. S. Goodman and A. Z. Gilman, *The Pharmacological Basis of Therapeutics* (Macmillan, New York, ed. 2, 1955), p. 1710.
7. J. A. Muntz, *J. Biol. Chem.* 182, 489 (1950).
8. O. Krayer, H. Farah, F. C. Uhle, *J. Pharmacol. Exptl. Therap.* 88, 277 (1946).
9. S. R. Korey, B. De Branganza, K. Nachmansohn, *J. Biol. Chem.* 189, 705 (1951).
10. T. H. Jukes and J. J. Oleson, *ibid.* 157, 419 (1945).
11. T. H. Jukes and A. C. Dornbush, *Proc. Soc. Exptl. Biol. Med.* 58, 142 (1945).
12. M. E. Reid, *J. Nutrition* 56, 215 (1955).
13. Papers describing these details are in preparation.

23 July 1957

Evidence that Glutamine Is a Precursor of Asparagine in a Human Cell in Tissue Culture

Previous work from this laboratory (*1–3*) has shown that glutamine is required for the growth of a wide variety of mammalian cells in tissue culture and that, in the case of the HeLa strain human carcinoma cell, it is utilized for protein synthesis without prior degradation. This conclusion was based in part on the observation that, when the cells were grown on a medium containing L-glutamine labeled with C^{14} in the carbon chain and N^{15} in the amide N, the glutaminyl residues of the protein had the same ratio of C^{14} to N^{15} as did the glutamine in the medium. Aside from the amide N of glutamine, the only constituent of the cell protein which contained appreciable N^{15} under these conditions was the amide N of asparagine (*2*) (Table 1). Unlike glutamine, asparagine was not an essential nutrient for these cells, and the close parallel between their N^{15} contents suggested the possibility that glutamine amide N might be a precursor of the asparagine of the protein. However, since the glutamine in the medium was degraded to glutamic acid and ammonia during the culture of the cells (*2*), these data offered no way of deciding whether the pathway between glutamine and asparagine proceeded by way of free ammonia.

Table 1. N^{15} content of the amide groups of the glutamine and asparagine of HeLa cell protein. The N^{15} content of the isolated amide N is referred to that of the precursor as 1. The values are corrected for the amount of protein present at the start of the experiment. The starting glutamine in various experiments contained from 2 to 8 atoms percent excess N^{15}; the NH_4Cl contained 20 atoms percent excess N^{15} in each instance. The conditions of cell growth, the determination of N^{15}, and the isolation of the glutamine and asparagine amide N from enzymatic hydrolyzates of protein by means of glutaminase and asparaginase have been described (*3*).

Precursor in medium	Expt. No.	Relative atoms percent excess in the isolated amide N	
		Glutamine	Asparagine
L-glutamine amide-N^{15}	1	1.2	1.2
	2	1.1	0.82
	3	1.1	0.86
	4	1.1	0.86
$N^{15}H_4Cl$	5	0.012	0.008
	6	0.012	0.008
	7	0.008	
	8	0.008	

If the incorporation of N^{15} into the amide group asparagine does involve ammonia as an intermediate, then culture of the cells in a medium containing $N^{15}H_4Cl$ should lead to labeled asparagine, provided that the ammonia in the medium is available to the cell for biosynthetic processes. Salzman in this laboratory has, in fact, shown (*4*) that when HeLa cells are grown with $N^{15}H_4Cl$, the intracellular soluble pool of ammonia is heavily labeled with N^{15}. Consequently, the data in Table 1, indicating that $N^{15}H_4Cl$ in the medium is not incorporated into the asparagine of the protein to any significant extent, indicate that free ammonia is not an intermediate between glutamine and asparagine. At least, if the transfer of the amide nitrogen of glutamine to asparagine does involve ammonia, then this ammonia is

not in equilibrium with the intracellular metabolite pool.

Free asparagine has been demonstrated in mammalian tissues (*5*) and plasma (*6*), and it appears to be a regular constituent of proteins (*7*). Ohno has recently shown (*8*) that lysozyme has 12 asparaginyl residues and only one aspartyl residue. Despite the wide occurrence of asparagine, little is known of its biosynthesis. Mardashev and Lestrovaya (*9*), on the basis of experiments with rat liver slices, proposed a transamidation between glutamine and aspartic acid yielding asparagine and glutamic acid, but there is as yet no unequivocal evidence for the proposed reaction. It should be emphasized that the results described in this report offer no clue to the mechanism of transfer of the amide group or to the nature of possible intermediates. They do, however, render it unlikely that asparagine is formed in this system by the direct amidation of aspartic acid by ammonia (*10*).

LEON LEVINTOW
National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

References

1. H. Eagle *et al.*, *J. Biol. Chem.* **218**, 607 (1956).
2. L. Levintow, *Federation Proc.* **16**, 211 (1957).
3. L. Levintow, H. Eagle, K. A. Piez, *J. Biol. Chem.*, in press.
4. N. P. Salzman, personal communication.
5. H. A. Krebs, *Biochem. J.* (*London*) **47**, 605 (1950).
6. G. Ågren and T. Nilsson, *Acta Chem. Scand.* **3**, 529 (1949).
7. M. Damodaran, *Biochem J.* (*London*) **26**, 235 (1932).
8. K. Ohno, *J. Biochem.* **41**, 345 (1954).
9. S. R. Mardashev and N. N. Lestrovaya, *Doklady Akad. Nauk S.S.S.R.* **78**, 547 (1951).
10. G. C. Webster and J. E. Varner, *J. Biol. Chem.* **215**, 91 (1955).

5 July 1957

Acquisition of Resistance to Osteolathyrism during Adaptation to Cold

"Crossed resistance" is a condition in which exposure to one agent induces resistance to another agent (*1*). Analysis has shown that, in most instances, this phenomenon is due to the fact that the stress of exposure to a noxious agent results in a discharge of glucocorticoids which, in their turn, inhibit responsiveness to other agents. It has been shown, for example, that through this mechanism, exposure to stressors (cold, muscular exercise, trauma, and infections) can inhibit the lung edema normally produced by adrenaline, the anaphylactoid reaction usually elicited by egg white or dextran, and many other types of inflammatory responses (*2*).

Since the thyroid also participates in certain systemic adaptive reactions, it seemed of interest to determine whether an increased endogenous secretion of thyroid hormone could likewise produce a phenomenon of "crossed resistance."

Experimental osteolathyrism is a disease characterized by excessive proliferation and degeneration of bone and junction-cartilage tissue (not to be confused with the clinical lathyrism, which affects the nervous tissue selectively). This skeletal disease, which is usually induced in the rat by treatment with *Lathyrus odoratus* or aminoacetonitrile (AAN), can readily be prevented by thyroxin (*3*). It is well known, furthermore, that exposure to cold augments the secretion of thyroid hormone. Could this stimulation of the thyroid during adaptation to a low temperature afford protection against intoxication with aminoacetonitrile?

Thirty female Sprague-Dawley rats with a mean initial body weight of 97 g (range 90 to 107 g) were subdivided into three equal groups. Group I was kept at room temperature throughout the experiment. Group II was kept at 0°C during treatment with aminoacetonitrile and group III was kept at 0°C for 10 days before and during aminoacetonitrile treatment. Aminoacetonitrile hydrosulfate was administered to all three groups, by stomach tube, at the daily dose level of 12 mg (6 mg in 0.2 ml of water twice daily). The experiment was terminated after 16 days of aminoacetonitrile treatment. At autopsy the skeleton was examined macroscopically, and one femur of each animal was fixed and simultaneously decalcified in Susa solution for the subsequent histologic examination of paraffin-imbedded sections stained with hematoxylin-eosin.

Mere macroscopic inspection of the bones sufficed to show that all the control animals (group I) had developed severe osteolathyrism, with multiple exostoses at tendon-insertion sites and excessive periosteal bone formation. Only traces of such changes were seen in group II, and none were seen in group III (Fig. 1). Histologic examination of the bones merely confirmed the macroscopic findings.

The histologic structure of the thyroid was essentially normal in group I, while in the two groups exposed to cold, the thyroid showed cellular hypertrophy and hyperplasia.

Since thyroidectomized rats do not withstand exposure to cold, it was impossible to verify the importance of the thyroid gland in the development of this kind of "crossed resistance" by control experiments on thyroidectomized animals. However, we know that small doses of thyroxin can inhibit osteolathyrism, and exposure to cold did, in fact, cause thyroid stimulation under our experimental conditions. Therefore, it appears justifiable to conclude that the resistance to osteolathyrism, which develops during adaptation to cold, is probably

Fig. 1. Femur of AAN-treated rat kept at room temperature (group I) (left) and femur of a rat which had been kept in a refrigerated room during AAN administration (group II) (right). There is intense bone proliferation (especially in the upper two-thirds of the femur) and widening of the junction-cartilage line (in the distal extremity of the bone) under the influence of AAN at room temperature. These changes are inhibited in the rat that had been kept in the cold.

the result of an increased secretion of thyroid hormone.

These experiments furnish us with still another example of an experimental disease whose development is decisively influenced by a hormone. They show, furthermore, that the amount and type of hormone normally secreted by the thyroid during adaptation to cold suffices to induce resistance against a severe experimental malady (*4*).

HANS SELYE
Institut de Médecine et de Chirurgie expérimentales, Université de Montréal, Montreal, Canada

References and Notes

1. H. Selye, *Arch. intern. pharmacodynamie* **55**, 431 (1937).
2. ———, *Stress* (Acta, Montreal, Canada, 1950).
3. ———, *Rev. can. biol.* **16**, 1 (1957).
4. These investigations were subsidized (in part) by a consolidated grant from the Department of Health of the Province of Quebec and by a grant from the Abbott Laboratories. I am also indebted to the Abbott Laboratories for supplying the aminoacetonitrile (AAN) used in these experiments.

10 July 1957

Thorium Content of Stone Meteorites

The abundance and distribution of thorium in many terrestrial rocks and in meteorites have not been well defined, owing to the difficulty of detecting the small amounts of thorium involved, compounded with the problem of contamination by extraneous thorium at such low

concentrations. Recent measurements of uranium in meteorites (*1*) have shown lower concentrations than have been generally accepted previously. This has served to renew interest in the companion problem of the concentration of thorium in meteorites, since in dispersed phases in terrestrial rocks, at least, the limited evidence available indicates that thorium and uranium occur in a fixed ratio of about 3 to 4 parts of thorium to 1 part of uranium.

Measurements of thorium in meteorites were undertaken independently at about the same time by one of us (H.A.P.), at the request of H. C. Urey, and by the other two of us (G.L.B. and J.R.H.), using the common technique of neutron activation. It is the purpose of this article to report jointly the collective data now at hand.

Jenkins (*2*) has summarized the analytical difficulties encountered in thorium analysis by means of conventional techniques and has demonstrated the two major advantages of the method of neutron activation—namely, high sensitivity and freedom from effects of reagent contamination during chemical processing after irradiation. However, Jenkins' method is based on radiochemical assay of thorium-233, whose 23-minute half-life requires rapid chemical processing.

The analyses reported here have been based on radiochemical assay of protactinium-233, the 27.4-day daughter of Th^{233}. Ease of chemical processing is greatly enhanced with the longer-lived Pa^{233}. Although the use of Pa^{233} diminishes the sensitivity of the method, owing to the lower specific activity relative to Th^{233}, a further advantage is gained in that the samples may be permitted a cooling-off period of several days, with a substantial reduction of the extraneous activity from short-lived emitters.

Table 1 summarizes the analyses of meteorites completed to date. Samples marked *a* were analyzed by Potratz, using the gross β^- activity of Pa^{233} following irradiation in the boiling-water reactor at Los Alamos; samples designated *b* were analyzed by Bate and Huizenga, using the associated 310-kev γ-activity of Pa^{233} following irradiation in the Argonne CP-5 heavy-water reactor. The methods differed further in the chemical processing techniques followed (*3*). In all cases the thorium concentrations were determined by comparison with the activity of a flux monitor of known thorium content, irradiated simultaneously with the samples.

The data reported generally represent the averages of at least two analyses in each case and are believed to be accurate within 10 percent, including uncertainties attributable to counting statistics. With the exception of Holbrook, the chondrites exhibit a fairly uniform thorium concentration. Although there is no reason to suspect the Holbrook datum on analytical grounds, it should be pointed out that the Holbrook sample consisted of small pebbles and could therefore be more susceptible to thorium contamination before irradiation because of the large surface area involved. The two achondrites show a wide variation of thorium content, which may not be unexpected, since the concentrations of other elements are known to vary widely in achondrites.

Table 1. Thorium in stone meteorites. (*a*) Analysis by Potratz, samples supplied by H. C. Urey. (*b*) Analysis by Bate and Huizenga, samples supplied through cooperation of B. H. Mason, American Museum of Natural History, New York, and of H. H. Nininger, American Meteorite Museum, Sedona, Ariz. (*c*) Uranium concentrations reported by Hamaguchi, Reed, and Turkevich (*1*). (*d*) Patterson (*4*). (*e*) Reasbeck and Mayne (*6*). (*f*) Davis (*5*).

Sample	Thorium concn. (10^{-8} g Th/g sample)		Uranium concn. (10^{-8} g U/g sample)	
Chondrites				
Beardsley	4.3	(*b*)		
Forest City	4.0	(*a*)	20 (*d*)	1.0 (*c*)
Forest City	4.7	(*b*)	20 (*d*)	1.0 (*c*)
Holbrook	9.0	(*b*)		1.3 (*c*)
Modoc	4.5	(*a*)	50 (*d*)	1.1 (*c*)
Achondrites				
Johnstown, Colo.	.55	(*b*)		
Nuevo Laredo	54	(*a*)	70 (*d*)	13 (*c*)
Olivine phase of pallasite				
Brenham, Kan.	1.1	(*b*)	5.3 (*e*)	0.69 (*e*) < 0.09 (*f*)

The only meteorite analyzed in common by the two methods is Forest City. The sample portions involved were not identical, and their relationship is not known; hence, a rigorous comparison of the two results is not possible. It may be noted that the thorium contents of Forest City, Modoc, and Nuevo Laredo are considerably smaller than are those computed by Patterson (*4*) to account for measured lead isotopic compositions, as is indicated for comparison in the table. In general, the results shown in Table 1 compare favorably with those for uranium in the same meteorites reported by Hamaguchi, Reed, and Turkevich (*1*), if a thorium-to-uranium ratio of about 4 to 1 is an acceptable criterion for comparison. By the same criterion, our thorium content for Brenham olivine is at least 3 times the value expected from the uranium content found by Davis (*5*) and is about one-fifth of the thorium value (Table 1) reported by Reasbeck and Mayne (*6*).

In contrast with the essentially uniform thorium content of chondrites previously noted, the value of $(39 \pm 8) \times 10^{-8}$ g of thorium per gram of sample, reported by Chackett and coworkers (*7*) for a portion of the chondritic Beddgelert meteorite, is discordant by nearly an order of magnitude. Although the data thus far enumerated are insufficient for extensive generalizations, they indicate that the neutron activation technique gives generally lower thorium values than do conventional nonactivation methods (used for all previous thorium analyses cited in the references). The spread of the data may, of course, be real, attributable to random variations from meteorite to meteorite of the same type or to variations within a given sample caused by statistical distribution of high thorium-bearing inclusions (an effect becoming increasingly pronounced with lower thorium concentrations and with reduced sample size).

If, however, these discrepancies are to be attributed to differences in methods of analysis, then it would appear that either reagent contamination is not yet completely accounted for in conventional nonactivation methods or neutron activation is sensitive to the matrix in which thorium occurs (primarily with reference to differences between the flux monitor and the sample). The latter factor is regarded as a possibility, but it is difficult to conceive of a mechanism to account for a discrimination factor approaching an order of magnitude. In the work at both Argonne and Los Alamos, flux monitors were prepared by introducing a known amount of thorium into a meteorite matrix, which should constitute an ideal flux monitor. This problem is receiving continued study, and as the validity of the method of thorium determination by neutron activation is further established, additional samples will be analyzed thereby (*8*).

George L. Bate*
J. R. Huizenga
Argonne National Laboratory, Lemont, Illinois
Herbert A. Potratz†
Los Alamos Scientific Laboratory, Los Alamos, New Mexico

References and Notes

1. G. W. Reed and A. Turkevich, *Nature* 176, 794 (1955); H. Hamaguchi, G. W. Reed, A. Turkevich, *Geochim. et Cosmochim. Acta*, in press.
2. E. N. Jenkins, *Analyst* 80, 301 (1955).
3. A detailed report is in preparation.
4. C. C. Patterson, *Geochim. et Cosmochim. Acta* 7, 151 (1955).
5. G. L. Davis, *Am. J. Sci.* 248, 110 (1950).
6. P. Reasbeck and K. I. Mayne, *Nature* 176, 186 (1955).
7. K. F. Chackett *et al.*, *Geochim. et Cosmochim. Acta* 1, 3 (1950).

8. This report is based on work performed under the auspices of the U.S. Atomic Energy Commission. The first two authors wish to thank D. W. Engelkemeir for the use of his 256-channel scintillation spectrometer. The last-named author wishes to thank G. A. Cowan and J. P. Mize and the members of the Los Alamos radiochemistry and reactor groups for their hospitality and for their assistance in this work.

* Permanent address: Department of Physics, Wheaton College, Wheaton, Ill.

† Permanent address: Department of Chemistry, Washington University, St. Louis, Mo.

15 July 1957

Effects of Gamma Radiation on Collembola Population Growth

Relatively little work has been done on the effects of ionizing radiations on populations, in contrast to the considerable body of work devoted to their effects, physiological and genetic, on individuals. Because of the interest of this laboratory in the disposal of low-level radioactive wastes into the soil, some research emphasis is being placed on radiation effects on populations of different soil arthropods. The Collembola, which are small, primitive, ametabolous, wingless insects, were chosen because they are abundant in soil, where they play a role in the breakdown of organic materials in the biological cycle of soil formation. Also, they are easily reared in the laboratory, have a short life-cycle, and will multiply rapidly. The species used in these studies was *Proisotoma minuta* Tull. (*1*), which is a ubiquitous form, known from North America, Europe, and Australia.

The effects of radiation on population growth rate were examined in these experiments. Increase in population size was measured by bidaily counts of individuals at food points and by counts of total numbers at the termination of the experiment. If the magnitude of the doses used reduced the numbers, this reduction could be construed to be an effect on the future potential of the population. Since certain important internal population parameters, such as age distribution, longevity, and sex ratios, were not known, and since these experiments were carried through only about three generations, only a crude index of the effect on the intrinsic rate of increase can be obtained.

The experiments were started with 61 reproducing population units of ten individuals each. Three doses of gamma radiation from a cobalt-60 source totaling 3000 r, 5000 r, and 7000 r were given in single exposures (at a dose rate of 19 r/sec) to these units. Sixteen replicates were used for each dose level; the remaining 13 were not irradiated. The experiments were terminated after 16 to 30 days, at which time the individuals were sacrificed and counted. At the end of the experiments 42,504 individuals were present.

There was a significant difference ($P = 0.001$) in the total numbers between the control and irradiated populations. The means of the treatments appeared to be linearly related to dose. A negative linear regression was significant at greater than 0.001 probability, while the deviations from linearity were not significant. Means of the bidaily sample counts, with their standard errors, are given in Table 1. Grand means (not shown) were as follows: control, 65.6 ± 6.9; 3000 r, 58.6 ± 5.6; 5000 r, 43.2 ± 3.7; 7000 r, 33.5 ± 2.4. An analysis of variance shows the difference between treatments to be significant; this significance appears to be the result of differences between extremes (controls versus 5000 r and 7000 r; 3000 r versus 7000 r) rather than of differences between adjacent means.

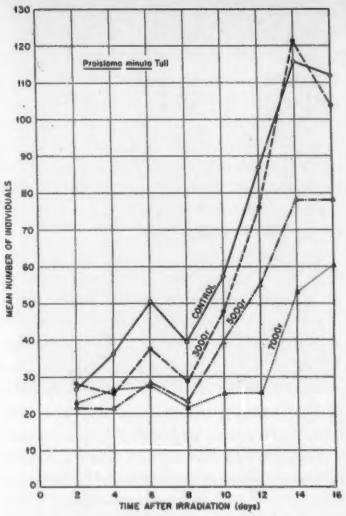


Fig. 1. The effect of acute gamma radiation on growth of Collembola population units as shown by bidaily counts of individuals at feeding points.

The bidaily counts at food points show that all the population units had an initial threshold period followed by the typical phase of exponential growth (Fig. 1). The effect of radiation seems to be chiefly one of lengthening the threshold period. When this lag phase has been passed, the population (with the possible exception of those units given 7000 r) then proceeds to multiply at the control rate. Until asymptotic levels are approached by all experimental cultures, the totals at any sampling point in time prior to reaching plateau reflect the lag effect.

Table 1. Means of sample counts taken every 2 days after irradiation. Shown are means for 2, 4, 6, 8, 10, 12, 14, and 16 days post-irradiation, reading from top to bottom.

Control mean ($N_i = 13$)	3000 r mean ($N_i = 16$)	5000 r mean ($N_i = 16$)	7000 r mean ($N_i = 16$)
26.7 ± 9.7	28.0 ± 7.4	21.5 ± 5.3	23.0 ± 5.0
36.0 ± 7.7	25.2 ± 5.6	21.1 ± 4.5	26.6 ± 5.9
50.6 ± 14.4	37.5 ± 9.5	28.1 ± 5.9	27.5 ± 6.3
39.2 ± 9.9	28.7 ± 5.3	23.1 ± 3.5	21.6 ± 3.2
57.5 ± 12.5	47.8 ± 10.2	39.6 ± 9.4	25.2 ± 4.3
87.0 ± 24.6	76.2 ± 15.6	55.0 ± 11.7	25.8 ± 4.1
115.8 ± 26.4	121.3 ± 23.8	78.1 ± 13.4	53.0 ± 8.5
111.8 ± 25.2	103.8 ± 19.3	78.6 ± 12.9	60.2 ± 8.2

S. I. Auerbach
D. A. Crossley, Jr.
Health Physics Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee

Manfred D. Engelman
Department of Zoology, University of Michigan, Ann Arbor

Note

1. We wish to thank D. L. Wray, Division of Entomology, North Carolina Department of Agriculture, for the identification of this species.

9 July 1957

Book Reviews

Bioenergetics. Albert Szent-Györgyi. Academic Press, New York, 1957. x + 143 pp. Illus. + plates. $4.50.

Bioenergetics is the latest in a series of books in which Albert Szent-Györgyi has given us a lively running account of his efforts to understand the chemical and physical bases of life-processes.

The present work is about the utilization of energy by living things. It is based on an evaluation of our present knowledge of cellular chemistry, which no student of biochemistry can afford to forget. We know a great deal about how cells release energy from foodstuffs but very little about how this energy is put to use as work. What is more, "Dazzled by our successes we even forget to ask."

With characteristic directness, Szent-Györgyi dedicates his book to an attack on this area of ignorance, for he is convinced that "Such a schism between the known and the unknown suggests that some basic information is missing."

The problem is to discover how the energy that is associated with a chemical bond, and which has no influence beyond the limits of a given molecule, may be converted into a transferable, externally active form. To make matters easy for biologists, and to avoid "an argument with statistical mechanics," Szent-Györgyi adopts separate notations for the two types of energy, the symbol E^* representing the transferable form which accomplishes work. E^* is associated with an excited state of a solid system and represents energy transferable within such a solid. Biological macromolecules, especially proteins and nucleic acids, are solid-state systems capable of conducting E^* and delivering it to the point at which it may link up with a work process.

This proposition stated, Szent-Györgyi devotes several succeeding chapters to presentation of supporting evidence. The evidence is derived from relatively simple experiments on fluorescence and phosphorescence. Since excited states of the type denoted by E^* frequently decay by delayed emission of light, these phenomena are a source of rough information about systems capable of generating and transferring E^*. The evidence is suggestive rather than final. Nevertheless, the experimental facts provide Szent-Györgyi with a framework for some stimulating discussions of the problem of energy transfer in biological systems and the possible roles played by biologically important substances, especially water.

The remainder of the book is frankly speculative, dealing with possible relations between E^* and various aspects of normal and pathological biology. Szent-Györgyi's speculations are always worth reading.

This book is valuable because it is an eloquent plea that we give attention to the vital areas which modern biochemistry, which is so successful in other ways, appears to be unable to master. Biochemical analysis of cellular processes is based on the behavior of dilute homogeneous solutions. The conceptual framework is that of the chemist; its cornerstone is the chemical reaction between colliding molecules. What Szent-Györgyi tells us is that the reactive systems of the cell are not solutions but structurally organized solids and that the chemical events of life are more nearly related to solid-state physics than they are to solution chemistry.

A partisan of Szent-Györgyi's cause would wish that his appeal were more firmly founded on modern solid-state physics. This field is developing at a remarkable rate, but relatively little of recent knowledge about energy transport in solids is reflected in Szent-Györgyi's book.

This failing is not wholly Szent-Györgyi's responsibility. His first plea that biochemistry take heed of the solid state was made 16 years ago in an article in *Science* [**93**, 609 (1941)]. Six years later, in his essay on the continuum theory—which is essentially the same as his present proposal—Szent-Györgyi made some trenchant comments on the impact of this previous article. "In the course of my career as a biochemist I was more and more depressed by the feeling of complete failure, not being able to explain a single reaction. Much relieved by the new theory of matter (*i.e.*, energy levels in solid semiconductors), I gave vent to my joy in an article in *Science* entitled 'Towards a New Biochemistry?' By this rather ambitious title I wanted to emphasize that the application of this new theory to living systems might mean a new period in biochemistry. The reaction to this article was rather amazing: There was none at all" (in *Muscular Contractions*, Academic Press, New York, p. 97).

If Szent-Györgyi's first call had been heeded by biochemists and other investigators, the intervening 16 years might have seen a vigorous application of solid-state physics to the problem of biology, and we would now be able to substitute fact for speculation.

The readability of this book is somewhat marred by printing defects.

BARRY COMMONER
Washington University

Educating Gifted Children. Robert F. DeHaan and Robert J. Havighurst. University of Chicago Press, Chicago, Ill., 1957. ix + 276 pp. $5.

Educating Gifted Children is one more book in the considerable number which have appeared in recent years evidencing the mounting interest in superior youngsters and awareness of the importance of finding them and nurturing their potentialities. As is set forth in this volume, there is a responsibility for helping gifted children not alone for their sake and for that of the community; the international situation makes it urgent that this country find its best young people and give them such training and opportunities as will bring them to maximal fruition.

The treatment is systematic and broad, and it aims at practicality. Thus, the third chapter, on screening children for ability, considers tests of various types and also ways of systematizing the observation of teachers, parents, and other children in locating exceptional talents of various sorts—as in science, the fine arts, and music. A following chapter, on screening programs in action, describes ways of setting up such programs in a school or school system, with a chapter next following on administrative aspects of an educational program for gifted children.

Other chapters deal with the long-standing controversy between enrichment and acceleration (why not, the authors wisely and diplomatically say, some of both?); with motivation of the gifted; with values of special grouping and ways of serving the gifted child in the classroom; and with the development of creativity and special talents. Unusual breadth is evidenced by chap-

ters on community factors and resources in the education of the gifted and on the gifted child in the family.

As has already been implied, the consideration is of youngsters in the elementary and secondary schools rather than students in college, although integration of the work of secondary school and college is touched on. There is much illustrative material, there are appendixes listing tests useful in locating superior children and organizations interested in them, and there is a classified annotated bibliography.

To me it seems unfortunate that there is no mention of Lehman's monumental work on age of achievement and of his finding that best creative work tends to be done early in the young adult years. In view of the increasingly long preparation now required in scientific and other fields, that finding adds urgency to efforts to facilitate the progress of able young people into careers. But, in total, the volume is exceptionally broad in treatment, in the sources on which it draws, and in the variety and practical nature of the suggestions of ways in which schools may find and foster the talents of the gifted.

S. L. PRESSEY

Ohio State University

Plant Virus Serology. R. E. F. Matthews. Cambridge University Press, New York, 1957. xi + 128 pp. Illus. $5.

This excellent little volume is a manual of laboratory methods in plant virology. Aside from the condensed account in Bawden's general textbook, it seems in fact to be the only existing description of plant virus serology.

There are 11 chapters: "Introduction," "Types of serological test," "Routine testing for virus infection," "Serological tests for determining relationships among plant viruses," "The precipitin reaction," "The antibody content of sera," "Methods of estimating virus concentration," "The cross absorption procedure," "Precipitation in mixed systems," and "The applicability of serological techniques." The first chapter is a general introduction and assumes no knowledge of serology on the part of the reader. The nature of subsequent chapters is well indicated by their titles. To avoid any possible misunderstanding, however, it may be remarked that the antibodies used are animal (rabbit) antibodies.

In addition to the quantitative nitrogen methods introduced into serology by Heidelberger and Kendall, the author makes much use of quantitative timing of the precipitin reaction, including the optimal proportions method introduced by Dean and Webb and modifications of this method suggested by Hooker and Boyd, and by Boyd, little used in this country. The author's interpretation of the beta optimum is somewhat different from that of the latter authors but not necessarily incorrect. These relatively little known methods, plus a serological chromatographic method attributable to Matthews, are evidently of great value, especially for estimating small amounts of virus.

The book is well illustrated by six plates and 12 text figures. There are a bibliography of more than 100 titles, a subject index, and an author index.

WILLIAM C. BOYD

Boston University

Development of Vertebrates. Emil Witschi. Saunders, Philadelphia, Pa., 1956. xvi + 588 pp. Illus. $8.50.

This textbook of embryology is based on a new and original plan, incorporating a considerable amount of material on experimental embryology, developmental physiology (especially metabolism), and the endocrinology of reproduction. Such a plan results in a far more complete and well-rounded elucidation of developmental processes than was possible in the older textbooks based on a strictly morphological approach. The author's research experience in the fields of experimental embryology and endocrinology has, of course, eminently qualified him to prepare this new type of presentation. The clarity of the writing and the excellence of the illustrations make the book a pleasure to read, and these features will be appreciated by the college students who will use it. Since students majoring in zoology or in premedical work (for whom the book is intended) may eventually enter fields of biological or medical research, rather than medical practice, this approach provides a valuable stimulus to the coming generation of research workers in the biological sciences.

A great deal of material is covered in the 588 pages; basic concepts are outlined (10 pages), and there are general sections on maturation of the gametes (33 pages), fertilization (11 pages), and cleavage and gastrulation (13 pages) as well as longer and more specialized sections on the development of fishes (24 pages), amphibians (118 pages), birds (146 pages), and mammals, including man (179 pages). Experimental material is incorporated in the sections on each form, and there are separate chapters dealing with the developmental physiology of each group. The conclusions, which are based on the experimental work, are well documented. There is an adequate bibliography (12 pages) of the more important recent and older references.

The relative emphasis on the various topics (indicated, in part, by the amount of space devoted to each) has been carefully considered and, in my opinion, correctly placed. In addition, the book has been kept sufficiently concise for use in a one-semester course by a rigid systematizing of the descriptive materials contained in the representative life-histories. As the author states in the introduction (page vi), the book aims to contribute toward "a realization, by the student, that development is a natural process which is open to scientific analysis by research methods not essentially different from those of the inorganic sciences."

The excellent, well-labeled illustrations utilize a variety of techniques, from photographs to line drawings, and are beautifully reproduced. Many of these figures have not been published before.

In short, the book is a usable and useful addition to the available textbooks of modern embryology.

D. P. COSTELLO

University of North Carolina

The Genus Achlya: Morphology and Taxonomy. University of Michigan studies, scientific series. vol. XX. Terry W. Johnson, Jr. University of Michigan Press, Ann Arbor; Cumberlege, Oxford University Press, London, 1956. 180 pp. Illus. $4.50.

This short monograph deals with the largest genus of a family of aquatic Phycomycetes, the Saprolegniaceae, or "water molds." Taxonomically the entire family is a difficult one—extreme variability of vegetative and asexual structures leaves only the slightly less variable sexual organs and features as taxonomic criteria—in which the largest component genus certainly contains its full share of puzzling relationships and uncertainties. The author is clearly aware of these difficulties and limitations, uncomplainingly accepts them as completely unavoidable, and proceeds about the treatment of the group with admirable firmness and discrimination and with an equally admirable lack of pomposity: on page 74 he actually reduces *Achlya michiganensis* Johnson to synonomy. A great deal of effort obviously went into securing collections from widely scattered sources, particularly cultures or preserved samples, or both, of original materials from previous authors in the group; these materials, together with Terry Johnson's own numerous collections, constitute an extensive basis

for critical comparative evaluation. The keys are constructed on minimal discriminating criteria, and the many figures—simple line drawings—serve well to illustrate the inconspicuous but pertinent points of specific discrimination. The descriptions have been reworked, in many cases, from firsthand study of living material or from thorough reexamination of preserved original materials.

Commendable as this approach is in general—and in practically every case in particular—it led to one item of error that happens to lie within my spotting competence: the keyed distinction between the two heterothallic species of the genus, *A. bisexualis* and *A. ambisexualis*, is that the oospores (zygotes) of the former usually abort. This is a libel on a once perfectly virile fungus that has grown increasingly impotent under enforced and prolonged domestication, and precisely the same manifestations of senility now appear in the strains of *both* species that are currently available from the two culture collections in which they were deposited about 1951! In extenuation, however, it is a rare mycologist indeed who has not at one time or another been embarrassed by the sexual inconstancy of fungi in continued culture.

In addition to the taxonomic treatment of the genus *Achlya*, there is an all-too-summary introduction, comprising sections devoted to the history of the understanding of the biology of the group, the occurrence and distribution of its members in nature, and the methods of their collection, isolation, and culture. This introductory material could apply equally well to the entire group of water molds, and it is here that one could wish that the author had written with less restraint. The taxonomic problems here represent only one facet of a very interesting group of plants, and the book would have had far wider appeal had there been a broader treatment of the group.

To anyone who happens to have an unknown *Achlya* on his hands, the book will prove invaluable; it is not likely, unfortunately, to send anyone scurrying to the nearest pond in search of unknown *Achlyas* or to stimulate any appreciable new interest in an unusual group of plants that deserves greater recognition among biologists generally.

JOHN R. RAPER
Harvard University

Books Reviewed in The Scientific Monthly, October

Rockets, Missiles and Space Travel, W. Ley (Viking). Reviewed by T. S. Gardner.

Medical Department, United States Army, Surgery in World War II, vol. II, *General Surgery*, Office of the Surgeon General, Department of the Army. Reviewed by M. C. Leikind.

Quest for a Continent, W. Sullivan (McGraw-Hill). Reviewed by H. G. R. King.

Operation Deepfreeze, G. J. Dufek (Harcourt, Brace). Reviewed by H. G. R. King.

Natural History of Birds, L. W. Wing (Ronald). Reviewed by H. G. Deignan.

Family Medical Costs and Voluntary Health Insurance: a Nationwide Survey, O. W. Anderson with J. J. Feldman (Blakiston Div., McGraw-Hill). Reviewed by R. V. Lee.

1001 Questions Answered about the Seashore, N. J. Berrill and J. Berrill (Dodd, Mead). Reviewed by D. P. Abbott.

Nuclear Weapons and Foreign Policy, H. A. Kissinger (Harper). Reviewed by B. Brodie.

Archaeology in the U.S.S.R., M. Miller (Praeger). Reviewed by M. Gimbuta.

Light, Vegetation and Chlorophyll, J. Terrien, G. Truffaut, J. Carles; translated by M. E. Thompson (Philosophical Library). Reviewed by J. Bonner.

The Fight for Fluoridation, D. R. McNeil (Oxford Univ. Press). Reviewed by A. P. Black.

Follow the Whale, I. T. Sanderson (Little, Brown). Reviewed by W. E. Schevill.

The Language of Modern Physics, E. H. Hutten (Allen & Unwin; Macmillan). Reviewed by P. Suppes.

A History of Mechanics, R. Dugas; translated by J. R. Maddox (Griffon; Central Book). Reviewed by D. J. Price.

About Earthquakes, G. A. Eiby (Harper). Reviewed by B. Gutenberg.

The Amateur Astronomer, P. Moore (Norton). Reviewed by J. W. Chamberlain.

A Key to the Stars, R. van der Riet Woolley (Philosophical Library). Reviewed by J. W. Chamberlain.

New Books

Metallurgical Progress—3. A third series of critical reviews (reprinted from *Iron & Steel*). Iliffe, London; Philosophical Library, New York, 1957. 88 pp. $6.

Movement of the Heart and Blood in Animals. An anatomical essay. William Harvey. Translated from the original Latin by Kenneth J. Franklin and published for The Royal College of Physicians of London. Thomas, Springfield, Ill., 1957. 209 pp. $3.50.

Natürliche und Künstliche Erbänderungen. Probleme der Mutationsforschung. Hans Marquardt. Rowohlt, Hamburg, 1957. 177 pp.

Rogers' Inorganic Pharmaceutical Chemistry. Taito O. Soine and Charles O. Wilson. Lea & Febiger, Philadelphia, ed. 6, 1957. 705 pp. $9.50.

Polyethylene. Theodore O. J. Kresser. Reinhold, New York; Chapman & Hall, London, 1957. 217 pp. $4.95.

Radiation Shielding. B. T. Price, C. C. Horton, K. T. Spinney. Pergamon Press, London, 1957. 359 pp. $10.

Swine Feeding and Nutrition. Tony J. Cunha. Interscience, New York, 1957. 296 pp. $5.

A Textbook of Dairy Chemistry. vol. I, *Theoretical;* vol. II, *Practical*. Edgar R. Ling. Philosophical Library, New York, ed. 3, 1957. 227 pp.; 140 pp. $12 per set.

Vanguard! The story of the first man-made satellite. Martin Caidin. Dutton, New York, 1957. 288 pp. $3.95.

Zinsser Bacteriology. David T. Smith, Norman F. Conant and others, Eds. Appleton-Century-Crofts, New York, ed. 11 of *Textbook of Bacteriology* by Hiss and Zinsser, 1957. 966 pp.

Advances in Catalysis and Related Subjects. vol. IX, *Proceedings of the International Congress on Catalysis*. Philadelphia, 1956. Adalbert Farkas, Ed. Academic Press, New York, 1957. 865 pp. $16.

Animals Parasitic in Man. Geoffrey Lapage. Penguin Books, Baltimore 11, 1957. 320 pp. Paper, $0.95.

The Atlantic. A history of an ocean. Leonard Outhwaite. Coward-McCann, New York, 1957. 479 pp. $6.50.

Constructing an Astronomical Telescope. G. Matthewson. Philosophical Library, New York, ed. 2, 1957. 100 pp. $3.

A Dictionary of Scientific Terms. Pronunciation, derivation, and definition of terms in biology, botany, zoology, anatomy, cytology, genetics, embryology, physiology. I. F. Henderson and W. D. Henderson; ed. 6 by J. H. Kenneth. Van Nostrand, Princeton, N.J., ed. 6, 1957. 548 pp. $12.50.

The Direction of Research Establishments. Proceedings of a symposium held at the National Physical Laboratory 26–28 September 1956. National Physical Laboratory. Her Majesty's Stationery Office, London, 1957 (order from British Information Service, New York). 4 sections.

Drugs and the Mind. Robert S. de Ropp. St. Martin's, New York, 1957. 320 pp. $4.50.

Functional Neuro-Anatomy. Including an atlas of the brain stem. A. R. Buchanan. Lea & Febiger, Philadelphia, ed. 3, 1957. 362 pp. $7.50.

The Hebrew Iliad. The history of the rise of Israel under Saul and David. Written during the reign of Solomon probably by the priest Ahimaaz. Translated from the original Hebrew by Robert H. Pfeiffer; general and chapter introductions by William G. Pollard. Harper, New York, 1957. 154 pp. $2.50.

History of Entomology in World War II. Publication 4294. Emory C. Cushing. Smithsonian Institution, Washington, 1957. 123 pp.

An Introduction to Reactor Physics. D. J. Littler and J. F. Raffle. Published for the United Kingdom Atomic Energy Authority. McGraw-Hill, New York; Pergamon, London, ed. 2, 1957. 218 pp.

Magnetohydrodynamics. A symposium. Rolf K. M. Landshoff, Ed. Stanford University Press, Stanford, Calif., 1957. 125 pp. $4.

Meetings and Societies

Election of AAAS Officers

The following candidates for the offices of president-elect and members of the Board of Directors have been selected by the AAAS Committee on Nominations on the basis of a preliminary balloting of AAAS Council members:

President-elect (one to be elected)
Paul E. Klopsteg
Chauncey D. Leake

Members of the Board of Directors (two to be elected)
Glenn L. Jenkins
Thomas Park
William W. Rubey
Maurice B. Visscher

Ballots for election by preferential mail vote will be sent to council members by 10 November. Election procedures established by the council provide that additional candidates for any of the elective offices may be nominated and included on the ballot by a petition signed by no fewer than 30 members of the council and submitted to the executive officer no later than 1 Nov. The results of the election will be announced on 27 Dec. at the association's 1957 annual meeting in Indianapolis. Biographical data concerning each of the candidates follow.

Paul E. Klopsteg, 67 (physics), assistant in physics, University of Minnesota, 1911–13; instructor and later assistant professor, 1913–17; development engineer, Ordnance Department, U.S. Army, 1917–18; physicist, Leeds & Northrup Company, Philadelphia, 1918–21; director of research and manufacturing, Central Scientific Company, Chicago, 1921–30, president, 1930–44; professor of applied science, Northwestern University, director of research, Northwestern Technological Institute, 1944–54; assistant director for physical sciences, National Science Foundation, 1951, associate director since 1952, associate director for research, 1957–; deputy chief, instruments section, National Defense Research Committee, 1940–41, chief, physics (special devices) division, 1941–45; assistant chief, office field service, Office of Scientific Research and Development, 1944–45; chairman, committee on artificial limbs (Prosthetics Research Board), National Research Council, 1945–56, member, 1945–; member of the board of governors and chairman, Argonne National Laboratory, 1949–50; member, Personnel Security Review Board of AEC, 1953–; Modern Pioneers' award, National Association of Manufacturers, 1940; Presidential Medal for Merit, 1948; cofounder, American Association of Physics Teachers, 1930, president, 1953; member of the governing board, American Institute of Physics, 1930–45, chairman, 1938–45.

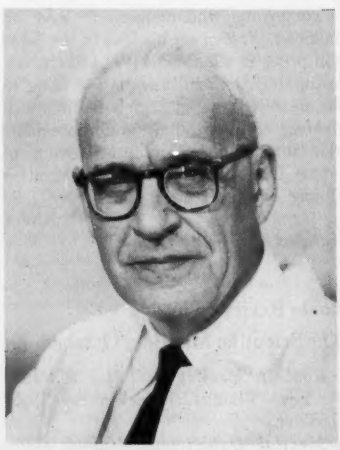
AAAS activities: member of the Board of Directors, 1949– and Executive Committee, 1953–; member, Building Committee, 1952–54, and Investment and Finance Committee, 1950–54; chairman, Committee on Public Information and Science, 1957–.

Chauncey D. Leake, 61 (pharmacology, physiology, history of science, health administration), Chemical Warfare Service, instructor in physiology, assistant professor of pharmacology, University of Wisconsin, 1919–28; professor of pharmacology and of history of medicine, lecturer in human relations, librarian, University of California Medical Center, San Francisco, 1928–42; director, professor of pharmacology and of history of medicine, University of Texas Medical Branch, Galveston, 1942–55; professor of pharmacology, assistant dean, Ohio State University, 1955–; special award International Anesthesia Research Society, 1928; president, History of Science Society, 1936–37; vice president, Society for Experimental Biology and Medicine, 1941–42; president-elect, American Society for Pharmacology and Experimental Therapeutics, 1957; chairman, Section on Pharmacology, American Medical Association, 1934; president, Honorary Consultants Army Medical Library, 1946–47; consultant, U.S. Department of Defense, U.S. Public Health Service, Veterans Administration; chairman, National Research Council Committee on Problems of Alcohol, 1947–54; founder and former editor of *University of California Publications in Pharmacology* and of *Texas Reports on Biology and Medicine*; associate editor *Isis, Journal of the History of Medicine, Excerpta Medica, Archives Internationales de Pharmacodynamie et de Therapie,* and *Geriatrics*; member, board of trustees, *Biological Abstracts,* 1956–; visiting member, Institute for Advanced Study, 1950, 1952, 1956; Logan Clendenning lecturer, University of Kansas, 1951; Wm. Snow Miller lecturer, University of Wisconsin, 1940, 1957; Josiah Trent lecturer, Duke University, 1956; Poynter lecturer, University of Nebraska, 1957.

AAAS activities: vice president and chairman of Section L, 1942, 1954; delegate to BAAS, 1953; member, Publications Committee, 1954–; member, Board of Directors, 1954–; chairman, Committee on Social Aspects of Science, 1957.

Glenn L. Jenkins, 59 (pharmacy, pharmaceutical chemistry), research fellow, 1922–24, instructor, 1924–27, University of Wisconsin; professor of pharmaceutical chemistry, University of Maryland, 1927–36, University of Minnesota, 1936–41; dean of the School of

Paul E. Klopsteg



Chauncey D. Leake

Glenn L. Jenkins

Thomas Park

Pharmacy and professor of pharmaceutical chemistry, Purdue University, 1941–; American Pharmaceutical Association, Ebert medal for research, 1936; chairman, Section on Education and Legislation, 1929–30, chairman, Scientific Section, 1936–37, president, 1949–50, chairman, council, 1940–41 and 1953–55; American Council on Pharmaceutical Education, 1948–54; American Association of Colleges of Pharmacy, president, 1944–46; National Formulary Revision Committee, 1930–47; U.S. Pharmacopoeia Revision Committee, 1940–; Indiana Interprofessional Health Council, 1941–, president, 1941–55; Indiana State Board of Health, 1944–; chairman, 1957; American Chemical Society, chairman, Purdue Section, 1949–50; associate editor, *Pharmaceutical Archives*, 1936–41; headed Pharmacy Mission to Japan, 1950.

AAAS activities: secretary, Section Np, 1938–55; vice president and chairman, Section Np, 1955–56.

Thomas Park, 48 (zoology, population ecology), National Research Council fellow, Johns Hopkins University, 1933–35; instructor in biology, Johns Hopkins University, 1935–36, associate, 1936–37; instructor in zoology, University of Chicago, 1937–39, assistant professor, 1939–42, associate professor, 1942–47, professor, 1947–, associate dean, Division of Biological Sciences, 1943–46; Rockefeller Foundation fellow, Oxford University, 1948; scientific attaché, American Embassy, London, 1949; Environmental Biology Panel, National Science Foundation, 1956–58; editor, *Ecology*, 1940–50; editor, *Physiological Zoology*, 1955–; editorial board, *Quarterly Review of Biology*, 1938–, *American Naturalist*, 1951–57; zoological adviser, *Encyclopaedia Britannica*, 1950–.

AAAS activities: member, Board of Directors, 1954–; chairman, Publications Committee, 1955–.

William W. Rubey, 58 (geology), instructor in geology, Yale University, 1922–24; successively geologic aid to principal geologist, 1920–44, geologist in charge, division of areal geology and basic sciences, 1944–47, research geologist since 1947, U.S. Geological Survey; chairman, division of geology and geography, 1943–46; general chairman, 1951–54, National Research Council; member, committee on geophysics and geography, Research and Development Board, 1947–50; president, Geological Society of America, 1949–50; vice president, American Geological Institute, 1950–51; member, divisional committee on mathematics, physics, engineering, science, National Science Foundation, 1951–55; member, board of directors, Geochemical Society, 1955–; councillor, American Philosophical Society, 1956–; visiting professor of geology, Institute of Geophysics, University of California (Los Angeles), 1954, California Institute of Technology, 1955, Johns Hopkins University, 1956.

AAAS activities: member, Board of Directors (appointed to fill unexpired term), 1957; committee on Section E, 1939–42; committee on Newcomb Cleveland prize, 1951; representative on board of directors, Science Service, 1956–.

Maurice B. Visscher, 56 (physiology), assistant, University of Minnesota, 1922–55; National Research Council fellow, University College, London, and University of Chicago, 1925–27; associate professor and professor of physiology, University of Tennessee, 1927–29; professor and head, department of physiology, University of Southern California, 1929–31; professor and head, department of physiology, University of Illinois, 1931–36; professor and head, department of physiology, University of Minnesota, 1936–; secretary, American Physiological Society, 1946–48, president, 1948–49, chairman, board of publications trustees, 1955–; board of directors, *Biological Abstracts*, president, 1949–53; board of directors, *Annual Reviews*; president,

William W. Rubey

Maurice B. Visscher

American Association of Scientific Workers, 1946–48; chapter president, American Association of University Professors, 1945–46; vice president, National Society for Medical Research, 1952–55; vice president, American Heart Association, 1950–51; president, Council of International Organizations of Medical Sciences, 1952–55; secretary general, International Union of Physiological Sciences, 1953–; member, National Academy of Sciences.

AAAS activities: council member, 1945–46; chairman, Special Committee on Civil Liberties, 1946–48.

Forthcoming Events

October

27–1. Atom Fair, New York, N.Y. (Atomic Industrial Forum, 3. E. 54 St., New York 22.)

28–29. American Cancer Soc., annual scientific session, New York, N.Y. (B. S. Miller, ACS, 521 W. 57 St., New York 19.)

28–29. Applied Meteorology, 1st natl. conf., Hartford, Conn. (R. N. Youtz, Connecticut Valley Power Exchange, P.O. Box 330, Hartford.)

28–30. Association of Military Surgeons of the U.S., annual, Washington, D.C. (R. E. Bitner, AMSUS, Suite 718, 1726 Eye St., Washington 6.)

28–31. American Nuclear Soc., 2nd winter, New York, N.Y. (J. Burt, J. M. Mathes, Inc., 260 Madison Ave., New York 16.)

29–31. Entomological Soc. of Canada, annual, Lethbridge, Alta., Canada. (R. H. Wigmore, Science Service Bldg., Carling Ave., Ottawa 3, Ont.)

29–3. Photoperiodism in Plants and Animals, internatl. conf., Gatlinburg, Tenn. (R. Winthrow, Division of Radiation and Organisms, Smithsonian Inst., Washington 25, D.C.)

30–31. Industrial Hygiene Foundation, 22nd annual, Pittsburgh, Pa. (C. R. Walmer, Industrial Hygiene Foundation, Mellon Inst., Pittsburgh.)

30–2. American Soc. of Parasitologists, annual, Philadelphia, Pa. (P. E. Thompson, Research Div., Parke, Davis & Co., Detroit 32, Mich.)

30–2. American Soc. of Tropical Medicine and Hygiene, annual, Philadelphia, Pa. (R. B. Hill, 3575 St. Gaudens Rd., Miami 33, Fla.)

30–2. Federation of Paint and Varnish Production Clubs, 35th annual, Philadelphia, Pa. (FPVPC, 121 S. Broad St., Philadelphia 7.)

31. Reactor Safety Conf., New York, N.Y. (Atomic Industrial Forum, 3 E. 54 St., New York 22.)

31–2. Engineering and Scientific Education Conf., Chicago, Ill. (J. E. Harrington, Western Soc. of Engineers, 84 E. Randolph St., Chicago 1.)

31–2. Gerontological Soc., annual, Cleveland, Ohio. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

November

2–8. World Metallurgical Cong., 2nd, Chicago, Ill. (W. H. Eisenman, American Soc. for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.)

2–10. Measuring Instruments and Automation, internatl. cong., Düsseldorf, Germany. (Nordwest Deutsche Ausstellungs Gesellschaft, M.B.H., Ehrenhof 4, Düsseldorf.)

3. American College of Dentists, annual, Miami, Fla. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis 8, Mo.)

3. Society of Vertebrate Paleontology, annual, Philadelphia, Pa. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

3–9. Pan American Cong. of Pharmacy and Biochemistry, 4th, Washington, D.C. (G. Griffenhagen, Smithsonian Institution, Washington 25.)

4–5. Crystal Structure Analysis by IBM 704 Computer, NBS Conf., Washington, D.C. (V. Vand, Pennsylvania State Univ., University Park.)

4–5. Society of Vertebrate Paleontology, technical sessions, Atlantic City, N.J. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

4–6. Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn. (D. D. Cowen, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tenn.)

4–6. Geological Soc. of America, annual, Atlantic City, N.J. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

4–6. Mineralogical Soc. of America, annual, Atlantic City, N.J. (C. S. Hurlbut, Jr., Dept. of Mineralogy, Harvard Univ., Cambridge 38, Mass.)

4–6. Paleontological Soc., annual, Atlantic City, N.J. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge 38, Mass.)

4–6. Society of Economic Geologists, annual, Atlantic City, N.J. (H. M. Bannerman, U.S. Geological Survey, Washington 25.)

4–7. American Dental Assoc., annual, Miami, Fla. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

6–8. Electrical Techniques in Medicine and Biology, Boston, Mass. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

7–8. Society for Applied Spectroscopy, 12th annual, New York, N.Y. (J. Hansen, 27 Tulsa Ave., Metuchen, N.J.)

7–8. Television and Radio in the Health Field, conf., Chicago, Ill. (American Medical Assoc., 535 N. Dearborn St., Chicago 10.)

7–9. Animal Care Panel, 8th annual, San Francisco, Calif. (R. J. Flynn, ACP, Box 299, Lemont, Ill.)

PHOTOVOLT Line-Operated Multiplier FLUORESCENCE METER Mod. 540

- High-sensitivity for measurement of low concentrations (full-scale setting for 0.001 microgram quinine sulphate)
- Micro-fluorimetry with liquid volumes as low as 1 ml
- Low blank readings, strict linearity of instrument response
- Universally applicable due to great variety of available filters, sample holders, adapters and other accessories
- Interference filters for high specificity of results and for determining spectral distribution of the fluorescent light
- High-sensitivity nephelometry for low degrees of turbidities
- Fluorescence evaluation of powders, pastes, slurries, and solids, also for spot-tests on filter paper without elution

Write for Bulletin #392 to

PHOTOVOLT CORP.

95 Madison Ave. New York 16, N. Y.

GRAF APSCO CHICAGO U.S.A.

MEDICAL MICROSCOPES

Most reasonably priced GUARANTEED Microscope on the market.

Made in West Germany

NEW DESIGN

EXCLUSIVE SAFETY FEATURES

HIGH QUALITY OPTICS

10X OCULAR

OBJECTIVES:

16mm (10X) N.A. 0.27

4mm (44X) N.A. 0.66

1.8mm (100X) N.A. 1.30

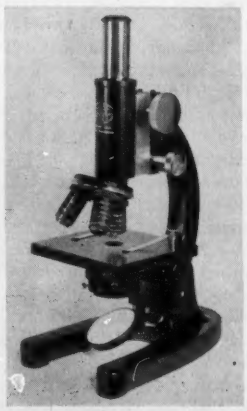
$192.00

TEN YEAR GUARANTEE

Write for catalogue listing safety features

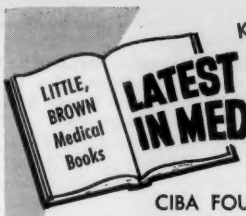
10% Discount on 5 or more. Models may be assorted to obtain this discount.

TRANSPORTATION INCLUDED



THE GRAF-APSCO CO.

5868 BROADWAY CHICAGO 40, ILL.



KEEP PACE WITH ALL THE

LATEST DISCOVERIES IN MEDICAL SCIENCE

CIBA FOUNDATION SYMPOSIA

PAPER ELECTROPHORESIS. The fact that this book has outsold all other Ciba books in an equal period of time is positive proof of the importance of the subject and the significance of the book itself. *Illus.* $6.75

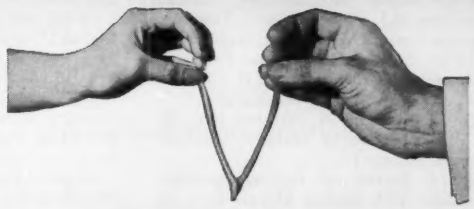
HORMONES IN BLOOD. This book points the way to future developments by an able and thought-provoking examination of the most advanced biological and chemical methods. *Illus.* $8.00

THE NATURE OF VIRUSES. A volume of far-reaching significance, epitomizing the fact that biochemical and biophysical studies of viruses have really come into their own. *Illus.* $8.00

IONIZING RADIATIONS AND CELL METABOLISM. The world's leading experts in a stimulating discussion establishing that we are well on the road to the control of diseases of metabolism caused by ionizing radiations. *Illus.* $9.00

At your medical bookstore or order directly from

LITTLE, BROWN & COMPANY
34 Beacon St., Boston 6, Mass.



WISHING . . . for one dependable source for research biochemicals?

Let NUTRITIONAL BIOCHEMICALS CORPORATION be the one answer to all your problems of quality, service, and economy in the biochemical field.

A COMPLETE SELECTION OF
MORE THAN 200 AMINO ACIDS AND PEPTIDES

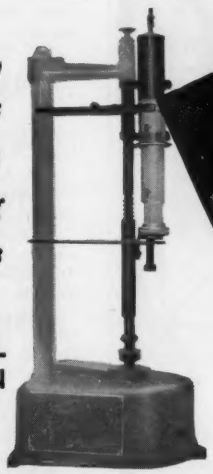
Typical Amino Acids

Glutamine	Valine, D, DL, L
Phenylalanine, D, DL, L	Ornithine, DL, L
Homoserine	Dopa, D, L, DL
Homocysteine	Asparagine, D, L, DL
Histidine	Serine, D, L, DL

NUTRITIONAL BIOCHEMICALS CORPORATION
21010 Miles Avenue . . . Cleveland 28, Ohio

Write For New Catalog July 1957 Over 1700 Items Write Dept. 102

new instruments for infusion and retracting of liquids



Syringe Driver

FOR GENERAL APPLICATION

HERE is an economical and convenient means for delivering small quantities of liquids at accurately controlled rates.

A threaded shaft, carrying a syringe holder and a pusher, is mounted in place of the regular drum spindle and rotated in the same manner. Syringes are clamped in place, or released by turning a single thumbscrew. The unit is designed to be attached to, and driven by, our Bird Kymograph #70-060. This propeller may be used with equal facility on our older model (four-speed kymograph.

Since any Luer syringe, from 5 ml. to 50 ml. capacity may be used, and since the kymograph drive provides a choice of five speeds, a wide range of delivery rates is available, as indicated in the following table.

This instrument has clinical applications in anaesthesia, surgery, gynecology, radiology and neuropsychiatry. It is particularly useful for administering small volumes of injectible drugs which are to be given over a period of time.

71-04990 Syringe Driver and Kymograph (less drum and drum shaft) and without syringe.

71-0499 Syringe Driver only.

Approximate Delivery Rates in Milliliters per minute.					
Syringe Capacity	5	10	20	30	50
Speed No. 1	.0046	.0059	.0118	.0157	.024
Speed No. 2	.023	.030	.059	.078	.12
Speed No. 3	.116	.148	.29	.39	0.6
Speed No. 4	.58	.78	1.48	1.96	3
Speed No. 5	2.9	3.7	7.4	9.8	15

SYRINGE RETRACTOR

Similar to the Bird Syringe Driver, (Catalogue No. 71-0499), but is designed for **withdrawing** samples of blood (or other liquids) at accurately controlled rates.

71-04992—Syringe Retractor and Kymograph (less drum and drum shaft) and without syringe.
71-04991—Syringe Retractor, complete with change-gears.

PHIPPS & BIRD, INC.
Manufacturers & Distributors of Scientific Equipment
6th & Byrd Streets - Richmond, Va.

7–9. Society of Rheology, annual, Princeton, N.J. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York.)

10–13. Society of American Foresters, 57th annual, Syracuse, N.Y. (H. Clepper, SAF, 415 Mills Bldg., Washington 6.)

10–13. Xi Sigma Pi, Syracuse, N.Y. (J. R. Parker, School of Forestry, Univ. of Georgia, Athens.)

10–14. Society of Exploration Geophysicists, 27th annual, Dallas, Tex. (J. C. Hollister, Colorado School of Mines, Golden.)

11–13. Radio Fall Meeting, IRE, Toronto, Ont., Canada. (V. Graham, RETMA, 11 W. 42 St., New York 26.)

11–14. American Petroleum Inst., 37th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

11–15. American Public Health Assoc., 85th annual, Cleveland, Ohio. (R. M. Atwater, APHA, 1790 Broadway, New York 19.)

11–15. American Soc. of Professional Biologists, annual, with American Public Health Assoc., Cleveland, Ohio. (A. F. Borg, Dept. of Bacteriology, Kansas State College, Manhattan.)

13–15. American Meteorological Soc., College Station, Tex. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

13–15. Clinical Chemistry Symp., Cleveland, Ohio. (F. E. Bunts Educational Inst., Cleveland, Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

13–15. Standards, 8th national conf., San Francisco, Calif. (American Standards Assoc., 70 E. 45 St., New York 17.)

13–16. Society of Naval Architects and Marine Engineers, 65th annual, New York. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

14–15. Operations Research Soc. of America, Pittsburgh, Pa. (M. L. Ernst, Box 2176, Potomac Station, Alexandria, Va.)

14–16. American Inst. of Mining, Metallurgical, and Petroleum Engineers, semiannual, Chicago, Ill. (H. N. Appleton, AIME, 29 W. 39 St., New York 18.)

14–16. American Soc. of Refrigerating Engineers, Chicago, Ill. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

17–22. Radiological Soc. of North America, annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse, N.Y.)

18–21. Magnetism and Magnetic Materials Conf., Washington, D.C. (L. R. Maxwell, U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md.)

18–22. American Soc. of Agronomy, annual, Atlanta, Ga. (L. G. Monthey, ASA, 2702 Monroe St., Madison, Wis.)

18–22. Citrus Virus Diseases Conf., Riverside, Calif. (J. M. Wallace, Dept. of Plant Pathology, Univ. of California, Riverside.)

18–9. Pacific Science Cong., 9th, Bangkok, Thailand. (Pacific Science Board, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

20–24. National Assoc. for Mental Health, annual, Atlantic City, N.J. (NAMH), 10 Columbus Circle, New York 19.)

25–27. American Acad. for Cerebral Palsy, 11th annual, New Orleans, La. (R. R. Rembolt, Iowa Hospital–School State University of Iowa, Iowa City.)

25–27. Physics and Dynamics of Fluids, APS, Bethlehem, Pa. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

28–29. American Physical Soc., St. Louis, Mo. (K. K. Darrow, Columbia Univ., New York 27.)

28–30. Central Assoc. of Science and Mathematics Teachers, 57th annual, Chicago, Ill. (L. Panush, Northeastern High School, Detroit 7, Michigan.)

29–30. American Soc. of Animal Production, annual, Chicago, Ill. (H. H. Stonaker, Animal Husbandry Dept., Colorado State Univ., Fort Collins.)

December

1–6. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

1–15. Bahamas Medical Conf., 4th, Nassau, Bahamas. (B. L. Frank, 1290 Pine Ave., West, Montreal, Que., Canada.)

2–5. Entomological Soc. of America, annual, Memphis, Tenn. (R. H. Nelson, ESA, 1530 P St., NW, Washington 5.)

4–8. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

4–10. American Acad. of Optometry, annual, Chicago, Ill. (C. C. Koch, 1506–1508 Foshay Tower, Minneapolis 2, Minn.)

5–7. Texas Acad. of Science, annual, Dallas. (G. C. Parker, Education Dept., Texas A&M College, College Station.)

6–7. Oklahoma Acad. of Science, annual, Enid. (J. T. Self, Dept. of Zoology, Univ. of Oklahoma, Norman.)

7–8. American Acad. of Dental Medicine, New York, N.Y. (S. Ross, 136 E. 36th St., New York 16.)

8–11. American Inst. of Chemical Engineers, annual, Chicago, Ill. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–11. Fluorides Symp., Cincinnati, Ohio. (Secretary, Inst. of Industrial Health, Kettering Laboratory, Eden and Bethesda Aves., Cincinnati 19.)

9–13. Eastern Joint Computer Conf., Washington, D.C. (H. H. Goode, Dept. of Electrical Engr., Univ. of Michigan, Ann Arbor.)

9–22. Southeast Asia Soil Science Conf., 1st, Manila, Philippines. (I. G. Valencia, Bureau of Soils, P.O. Box 1848, Manila.)

13–14. Association for Research in Nervous and Mental Disease, 37th annual, New York, N.Y. (R. J. Masselink, 700 W. 168 St., New York 32.)

17–19. Nuclear Sizes and Density Distributions Conference, Stanford, Calif. (R. Hofstadter, Stanford Univ., Stanford, Calif.)

19–21. American Physical Soc., Stanford, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

(See issue of 20 September for comprehensive list)

Your key to a new world of enjoyment

An incomparable portable telescope by America's leading manufacturer of astronomical instruments. Although it weighs only 45 pounds its sturdy construction, fork-type mounting and integral electric drive mark it as an instrument of professional quality.

Celestar

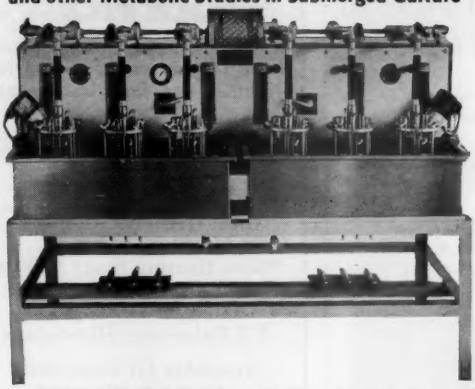
Complete with Electric Drive, Slow Motions, Right Ascension and Declination Circles, Heavy Duty Tripod and Finder Telescope.
Magnifications of 35X, 70X, 105X and 210X.

ONLY $198.50 f.o.b. Pittsburgh, Pa.

j. w. fecker, inc.
A Subsidiary of AMERICAN OPTICAL COMPANY
6592 HAMILTON AVENUE • PITTSBURGH 6, PA.

Integrated Pilot Plant for

Aerobic or Anaerobic Fermentations, Tissue Cultures and other Metabolic Studies in Submerged Culture



Accommodates 6 FERMENTORS, stainless steel with pyrex jars, capacities 5, 7.5 or 14 liters each; readily removable for thorough sterilization in autoclave; special non-freezing, non-bleeding ball bearing agitator housing and seals.
Stainless steel baths, thermostatically controlled within ± ½° C.; range, ambient to 60° C., approx. (cooling water connections for lower temperatures)
Twin drives for wide range of agitation and aeration rates, 150 to 750 r.p.m.
Complete with flow meters, air filters, metering valves.

UNCONDITIONAL ONE YEAR GUARANTEE

Write for Bulletin F600

NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY APPARATUS

P. O. BOX 606 • NEW BRUNSWICK, N. J.

Specify

DIFCO *. . . the only complete line of microbiological reagents and media*

Culture Media
Microbiological Assay Media
Tissue Culture and Virus Media
Serological Reagents Antisera
Diagnostic Reagents
Sensitivity Disks Unidisks
Peptones Hydrolysates Amino Acids
Enzymes Enrichments Dyes Indicators
Carbohydrates Biochemicals

•

60 years' experience in the preparation of Difco products assures
UNIFORMITY STABILITY ECONOMY

•

Complete Stocks Fast Service 24-hour Shipment

•

Difco Manual and other descriptive literature available on request

DIFCO LABORATORIES
DETROIT 1, MICHIGAN

an invaluable study of the bases of science-communication and measurement

COMMUNICATION ORGANIZATION & SCIENCE

by Jerome Rothstein

This new work will be of immeasurable assistance to everyone interested in fully understanding the modern field of cybernetics. In this important study the author shows that measurement and communication have the same underlying logical structure. He investigates the consequences of their close relationship to modern conceptions of entropy and organization.

A brilliant foreword by C. A. Muses adds a creatively critical dimension to the valuable concepts of this book and introduces a new and naturally related approach—that of chronotopology—to problems of the organization, interrelation, and interaction of events.

At your bookstore $3.50

THE FALCON'S WING PRESS INDIAN HILLS COLORADO

It's in Stock at **ACE**

THE NEW KIMBLE LINE OF KIMAX* **LABORATORY GLASSWARE** PLUS **FAMOUS EXAX WARE**

*Made of KG-33 Glass, A Borosilicate Glass which has outstanding resistance to heat, mechanical shock and chemical attack.

Interchangeable with, and can be sealed to, your present Borosilicate glassware.

Write for New Ace Supplement Listing this new line of glassware.

Also in stock at our Midwestern Division, Louisville, Ky.

ACE GLASS INCORPORATED
VINELAND ♦ NEW JERSEY
Midwestern Division
LOUISVILLE, KY.—Box 996
Specialists to Industry and Research

INDUSTRIAL APPLICATIONS OF RADIOISOTOPES WITH THE NEW AUTOMATIC TRI-CARB SPECTROMETER

Tracer Research involving industrial organic compounds — oil and gasoline, solvents, pharmaceuticals, plastics.

Ground Water Studies—large scale water distribution problems, such as pollution and waste disposal.

Large Scale Tagging of plant operation with safety and economy of radioactive materials.

Tri-Carb Liquid Scintillation Counting has opened many new possibilities for industrial applications of radioisotopes by making low level counting of soft beta emitters a simple routine procedure. Consider the following facts to see how this method might be applied to your own work.

Every single organic compound can be uniquely identified with the radioactive isotopes of hydrogen and carbon. These isotopes . . . Tritium and Carbon-14 . . . are readily available and simple to use. They emit very soft beta radiation which cannot penetrate even a thin glass container. Other common soft beta emitters that are now being successfully used in industrial applications are Sulphur-35 and Calcium-45.

Although the Tri-Carb Liquid Scintillation Spectrometer is sensitive enough to be used for natural radiocarbon dating of preserved organic materials that are over 40,000 years old, it is still simple enough to be used for counting hundreds of ordinary samples per day. Obviously the possibilities for practical industrial applications of radioactive tracers are greatly enhanced now that measuring equipment with this inherent sensitivity is available for routine use. Costs, safety, etc., cease to be limiting factors, and even the labeling of consumer products becomes a practical consideration.

For additional general information request Bulletin 314. For specific information on your requirements, provide application details.

Packard
INSTRUMENT COMPANY
Department A
P. O. Box 428 • LA GRANGE, ILLINOIS

A SPECIALIZED SERVICE

Complete microscope & microtome (any make) repair service, 48 hr. service. Loan instruments.

Authorized LEITZ Distributor

Microtomes
UAM Ortholux - Labolux
Florescence Access.
Micro Heating Stage 1000°C
MiniLoad Hardness Tester
XIC Micro - Projector
AM Polarizing Microscope

Available for immediate demonstration and delivery

CUSTOM MADE INSTRUMENTS

MONROE MICROSCOPE SERVICE
P.O. Box 656
Rochester 2, N.Y.

ADVANCES IN EXPERIMENTAL CARIES RESEARCH

AAAS SYMPOSIUM VOLUME
June 1955

246 pp., 6" x 9", 49 illus., index, clothbound

Price $6.75; cash order price for AAAS members **$5.75**

". . . This is a real contribution to dental science. It is the most comprehensive review of animal experimentation on caries ever attempted. The format and reproduction of illustrations are excellent.

"This compilation of research findings should have wide circulation and should be a storehouse of information for all those who are investigating the problem of dental caries. It should serve to clarify the thinking and prevent useless duplication in future studies. . . .".

Russell W. Bunting, School of Dentistry, University of Michigan.

AAAS, 1515 Mass. Ave., NW, Washington 5, D.C.

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ ELECTROCARDIOGRAPH is light and compact. A three-stage vacuum-tube input amplifier drives a three-stage transistor amplifier which in turn drives the galvanometer recorder. The galvanometer is very much smaller than those previously used. Total weight is 18 lb. (Sanborn Co., Dept. S605)

■ OPTICS DEMONSTRATOR consists of a single 3¼- by 4-in. glass-bound film containing more than 20 gratings of various numbers and dimensions and with spacings down to 800 per inch. A variety of interference and diffraction phenomena can be observed with the device, which was developed at the Cornell Aeronautical Laboratory. The device and its use are described in detail in *Am. J. Phys.* [**25**, 135 (1957)]. (National Press, Dept. S606)

■ ULTRAVIOLET MICROSCOPE uses television techniques to translate three selected ultraviolet wavelengths into three primary colors. Magnifications from specimen to screen of 4000 to 25,000 are possible. Resolution is of the order of 0.2 μ. A microspectrophotometer attachment displays the absorption of any selected ultraviolet wavelength along any of the horizontal scan lines. Absorption curves are displayed on a 5-in. screen. A quick-processing camera is provided for recording the curves. (Neutronics Research Co., Dept. S608)

■ SHELTER for use with tracking instruments consists of a steel cylinder 10 ft in diameter and 4 ft high topped by a hemispherical dome of reinforced plastic. The observation slot is 5 in. wide and extends 5 deg past the zenith. Rotation, unrestricted in either direction, is accomplished by an electrohydraulic drive unit with sprocket and chain. Maximum rotational velocity is 40 deg/sec. Maximum error between tracking-instrument position and dome position is 7 deg. (Coleman Engineering Co., Inc., Dept. S609)

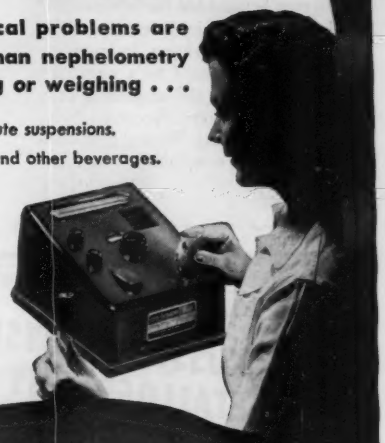
■ INFRARED SAMPLE CELL of variable thickness permits cancellation of background solvent absorption in infrared spectroscopy. Cell thickness may be varied over a range of 0.015 to 6 mm. Sample volume varies 2 to 10 cm^3 over this thickness range. Reproducibility of

Nephelometry..unties analytical knots

Many difficult analytical problems are quickly solved by Coleman nephelometry without filtering, drying or weighing . . .

- Concentration of solids in dilute suspensions.
- Clarity of liquids—whiskies and other beverages.
- Sterility of clear liquids —parenterals and vitamins.
- Growth rates of bacteria.
- Proteins in biological fluids.

Ask for 64 page manual, "Coleman Tools for Science"



COLEMAN

Coleman Nephelometers

Dept. S. Coleman Instruments, Inc., Maywood, Ill.

AT YOUR FINGERTIPS . . .

any precise d-c voltage up to 100 with

® REGATRON SUPER-REGULATED POWER PACKS

Model 212, AM. Price $149.00 with meters . . . 0 to 100 V dc, 100 ma. Regulation 0.1% or 0.02 volt over entire range of load and input voltage. Weight 14 lbs. 3½" H x 19" W x 9¼" D. Other models up to 3 amps.

®REGATRON Power Packs offer outstanding advantages in laboratory use. They are portable, lightweight, precise . . . yet they will withstand the rigors of continuous duty.

In the model shown above, a flick of a switch provides negative, positive, or ungrounded output . . . a vernier control provides accurate voltage settings over the complete voltage range . . . and full current output is available at all voltage settings, even at a fraction of a volt. Regulation is 0.1% or 0.02 volt over the entire voltage range.

REGATRON Power Packs have four rubber feet for table mounting, however, they can also be mounted in a standard 19-inch rack.

WRITE FOR BULLETIN

® Registered U.S. Patent Office. Patents Pending.

Electronic Measurements Company Incorporated

LABORATORY INSTRUMENT DESIGN & MANUFACTURING

EATONTOWN • NEW JERSEY

setting is better than ± 2 μ. Linearity is ± 2 percent or better for cell settings of 50 μ or greater. (Perkin-Elmer Corporation, Dept. S610)

■ PRESSURE TRANSDUCER measures gas pressure from 10^{-6} to 15 lb/in². Up to 35 v output is provided for telemetering. Acceleration sensitivity is less than 0.015 percent of the operating interval per grav. Pressure is sensed by a capacitive bridge which senses the displacement of a stretched diaphragm. Accuracy is ± 2 percent of the reading. Natural frequency is 3000 cy/sec. (Trans-Sonics Inc., Dept. S620)

■ CENTRIFUGE furnishes centrifugal field of 51,000 *g*. Twenty accurately regulated speeds from 2500 to 25,000 rev/min are selected by interchanging pulleys. Heat caused by windage friction is minimized by a combination of rotor insulation and ventilation. Convective stirring is said to be virtually eliminated. (Spinco Division, Beckman Instruments, Inc., Dept. S611)

■ MICROSCOPE COLD STAGE is designed for micro fusion studies over the range from − 100° to + 70°C. A stream of inert gas, precooled to a temperature below the expected melting point, is passed over the sample and escapes from the stage through a small annular space around the objective. Moisture is removed from the gas by an accessory cooling device. (Arthur H. Thomas Co., Dept. S613)

■ RUBBER STOPPER, designed to fit as many as 17 different openings from 22 to 100 mm in diameter, is essentially a size 15 stopper sliced into 17 concentric tapered rings. All rings are said to nest with a vacuum-tight fit. (Bethlehem Apparatus Co., Dept. S616)

■ THERMOCOUPLE REFERENCE JUNCTION provides a controlled temperature reference for up to 48 channels. Long-term temperature stability within 0.2°F is achieved with a resistance-bridge temperature-sensing system and a heater controlled by a magnetic amplifier. Reference temperature may be set from 25° above ambient to 250°F. (Pace Engineering Co., Dept. S617)

■ DENSITOMETER AND LIGHT METER is a selfcontained unit consisting of a light-sensitive crystal and a meter. Sensitive area is ⅛ by ¼ in. Controls are an off-on switch and a sensitivity switch. (Fotomatic Corporation, Dept. S621)

■ PRESSURE PICKUP is miniature model weighing 7 g. Output varies from 25 to 100 mv, full scale, depending on the pressure range. Sensing element is a strain gage with four active arms. Accuracy is ± 5 percent, and hysteresis is 0.25 percent. Excitation is 6 v alternating or direct current. Drift due to temperature is ± 0.01 percent/F°. Units are available in pressure ranges from 0 to 3 to 0 to 200 lb/in.² and in gage, differential, or absolute models. (Dynamic Instrument Co., Dept. S634)

■ MOTION-PICTURE CAMERA adjusts its lens opening automatically to accommodate to changing illumination. An iris diaphragm, operated by electric current generated in a photocell, operates the lens through its full range from *f*/1.9 to *f*/16 in less than 1 sec. Inadequate illumination, beyond the lens accommodation, is indicated by extinction of an amber light. Compensation for temperature changes, over the range tolerated by the film itself, is provided. (Bell and Howell, Dept. S635)

■ SYNTHETIC HEAT-TRANSFER FLUID, for electronic equipment, functions as a liquid at temperatures ranging from − 65° to + 400°F. The fluid, a silicate ester based compound, is electrically insulating and is compatible with practically all materials encountered in aircraft construction. (Monsanto Chemical Co., Dept. S637)

JOSHUA STERN
National Bureau of Standards

RUSSIAN PHYSICS AND METALLOGRAPHY RESEARCH

JUST PUBLISHED IN
COMPLETE ENGLISH TRANSLATION

QUANTUM ELECTRODYNAMICS, by A. I. Akhiezer and V. B. Berestetsky
An exposition on the basis of invariant perturbation theory, having significant practical advantages over the earlier methods, even for first-order calculations. Covers: The theory of free, i.e., noninteracting, particles (electrons and photons), considering the interaction as a perturbation; a definition of the vacuum as the state of the field in which no particles exist; development of invariant perturbation theory, and formulation of the interacting field equations; a general investigation of the S matrix, (concerte problems reduce to the calculation of S matrix elements) part of which analyzes the divergences in the S matrix, and describes the methods for removing them; a consideration of various concrete phenomena in the first nonvanishing approximation; development of the theory of radiative corrections, based on the methods for removing divergences. Appendices I and II describe: the general theory of free fields, important special cases of which are the electron-positron field and the electromagnetic field; the general theory of bound states. 549 pages $35.00

THE STATISTICAL THEORY OF PHASE TRANSITIONS, by B. T. Geilikman
Considers the statistical theory of phase transitions of the first and second order, based on the investigation of the general expression for the sum-over-states for a system of interacting particles. As a result of this investigation it becomes possible to state the conditions necessary for transitions of the first and second order, and to explain the mechanism of these transitions. 77 pages $15.00

PROBLEMS OF METALLOGRAPHY AND THE PHYSICS OF METALS, edited by B.Ya. Lyubov
The Fourth Symposium conducted by the Metallography and the Physics of Metals Institute of the Central Scientific Research Institute of Ferrous Metallurgy, USSR. Contains papers on the structure of liquid metals, crystallization processes and physical means of influencing their kinetics, phase transformations in steel, strengthening and weakening of steel and alloys, and numerous other important problems. 476 pages $30.00

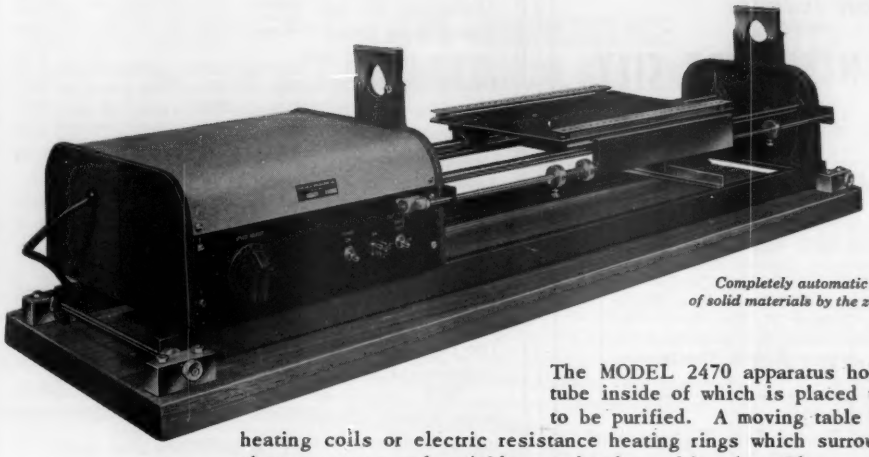
ISOTOPE PRODUCTION AND HIGH INTENSITY γ-SYSTEMS, edited by Yu.S. Frolov
Abstracts of 24 papers from this session, "Isotope Production . . .", at the All-Union Conference on the Application of Radioactive and Stable Isotopes and Radiation in the National Economy and Science, Moscow, April, 1957. 22 pages $7.50

Consultants Bureau translations by bilingual physicists. All material translated cover-to-cover, clearly reproduced by the multilith process, staple bound; includes all diagrammatic and tabular material integral with the text.

CONSULTANTS BUREAU, INC.
227 WEST 17th STREET, NEW YORK 11, N. Y. — U.S.A.
Telephone: ALgonquin 5-0713 • Cable Address: CONBUREAU, NEW YORK

The new **RSCo** MODEL 2470

ZONE MELTING APPARATUS



Completely automatic equipment for purification of solid materials by the zone melting technique

The MODEL 2470 apparatus holds a glass or quartz tube inside of which is placed the charge of material to be purified. A moving table holds either induction heating coils or electric resistance heating rings which surround the tube. A synchronous motor and variable speed reducer drive the table at a constant rate variable from 0.36 to 9 inches per hour. Adjustable stops limit the table travel and actuate a rapid return mechanism. Multiple-pass zone melting is thus completely automatic.

FOR FURTHER INFORMATION SEND FOR BULLETIN 2470-A OR CONTACT YOUR AUTHORIZED RSCO DEALER

RSCo

RESEARCH SPECIALTIES CO.

2005 HOPKINS ST. BERKELEY 7, CALIF.

KLETT ELECTROPHORESIS

CUSTOM MADE

TOOL FOR THE ANALYSIS OF COMPLEX COLLOID SYSTEMS, AND FOR THE CONTROL OF PRODUCTION OF PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87TH STREET
NEW YORK, N. Y.

ATOM FAIR 57

the trade fair of the atomic industry

COLISEUM, NEW YORK CITY

OCTOBER 28-31

sponsored by

ATOMIC INDUSTRIAL FORUM, Inc.

CONCURRENT WITH: 4th annual Forum atomic industry conference, October 28–30; winter meeting of American Nuclear Society, October 28–30; annual conference of IRE Professional Group on Nuclear Science, October 31, Nov. 1; and the Conference on Reactor Safety, sponsored by ANS, AIF and the U.S. Atomic Energy Commission, October 31.

For Complimentary Trade Fair Tickets *and* Conference Details—write:

DEPARTMENT AF

ATOMIC INDUSTRIAL FORUM

3 EAST 54 STREET, NEW YORK 22

AAAS SYMPOSIUM VOLUMES

6" x 9", illustrated, clothbound

Atomic Energy and Agriculture, 460 pp., 1957	$9.50
The Beginnings of Embryonic Development, 408 pp., 1957	8.75
Alcoholism, 220 pp., 1957	5.75
Tranquilizing Drugs, 205 pp., 1957	5.00
Venoms, 480 pp., 1956	9.50
The Future of Arid Lands, 464 pp., 1956	6.75
Water for Industry, 140 pp., 1956	3.75
Psychopharmacology, 175 pp., 1956	3.50
Luminescence of Biological Systems, 466 pp., 1955	7.00
Advances in Experimental Caries Research, 246 pp., 1955	6.75
Antimetabolites and Cancer, 318 pp., 1955	5.75
Monomolecular Layers, 215 pp., 1954	4.25
Fluoridation as a Public Health Measure, 240 pp., 1954	4.50
Sex in Microorganisms, 362 pp., 1954	5.75
The Present State of Physics, 271 pp., 1954	6.75
Astronomical Photoelectric Photometry, 147 pp., 1953	3.75
Soviet Science, 128 pp., 1953	1.75
Industrial Science, 160 pp., paperbound, 1952	2.00

7½" x 10½", double column, illustrated, clothbound

Centennial, 319 pp., 1950	5.00
The Rickettsial Diseases of Man, 255 pp., 1948	6.25
Mammary Tumors in Mice, 231 pp., 1945	3.50

AAAS,
1515 Mass. Ave., NW, Washington 5, D.C.

PERSONNEL PLACEMENT

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below — no charge for Box Number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

Single insertion	**$22.00 per inch**
13 times in 1 year	**21.00 per inch**
26 times in 1 year	**20.00 per inch**
52 times in 1 year	**19.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS OPEN

CHALLENGING FUTURE FOR MICROBIOLOGIST

The Research Council of Alberta, in its petroleum and coal research, desires an able scientist to initiate microbiological research. Investigations are to bear on the influence of microbiological factors in the origin and alterations of oil and coal. This position provides an opportunity for fine basic research in relation to two of the Council's major projects. Send your résumé to Secretary, Research Council of Alberta, 87 Avenue and 114 Street, Edmonton, Alberta, Canada. 9/27; 10/4

Director, diagnostic and research tuberculosis laboratory, central Florida, physician or nonphysician microbiologist or clinical chemist. Part-time employment will be considered. Write Dr. Albert V. Hardy, Director, Bureau of Laboratories, State Board of Health, P.O. Box 210, Jacksonville, Florida. uc

POSITIONS OPEN

(a) **Analytical Chemist and Biochemist, Ph.D.'s,** to direct groups, new research center, large industrial company; Pacific Coast. (b) **Clinical Chemist,** Ph.D.; large general hospital; East; $8000–$10,000. (c) **Associate Director of Research** in charge of pharmaceutical and organic research; key position, one of major pharmaceutical companies; attractive contract; medical school city, Midwest. (d) **Biophysicist or Biochemist,** Ph.D., to serve as consultant, research institute specializing in cardiovascular research; plans complete for increasing scope into other research fields; $10,000–$12,000; medical center, Midwest. (e) **Biochemist** qualified enzymes to supervise research and biochemical manufacturing, pharmaceutical company; minimum $8000; East. (f) **Biochemist or Nutritionist** with some experience as science writer; duties include surveying literature for various departments, pharmaceutical company; $7000–$10,000; Midwest. S9-4, Medical Bureau, Burneice Larson, Director, 900 North Michigan Avenue, Chicago. X

Experimental Histopathologist. Ph.D. or M.D. Cancer and cardiovascular research program. Give qualifications and salary expected. W. D. Salmon, Alabama Polytechnic Institute, Auburn, Alabama. 10/4

Medical Technicians, General (male) for employment with U.S. Government. Under 38 years of age. Must be U.S. citizen. Military experience in medical field desirable. Knowledge of x-ray and laboratory procedures necessary. Willing to serve overseas. Beginning salary $4080 per annum plus allowances. We request that initial reply include professional background and military experience. Box 235, SCIENCE. 8/16, 23, 30; 9/6, 13, 20, 27

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

POSITIONS OPEN

MICROBIOLOGIST. Ph.D., recent graduate with experience or training in tissue culture and virology. Responsible research position with rapidly expanding veterinary biological and pharmaceutical manufacturer located in Midwest. Fine working conditions, liberal employee benefits, including a profit-sharing program, and excellent opportunity for advancement. Please send complete résumé, including approximate salary requirements, references, and data available in first letter. Our employees know of this ad and all inquiries will be held in strict confidence. Box 267, SCIENCE. 10/4, 11, 18

Microbiologist—Tissue Culture. Position available for very able Ph.D. in eastern pharmaceutical company. Would prefer experience in tissue culture, but willingness to learn is an acceptable substitute. Please indicate qualifications. Box 259, SCIENCE. 9/27; 10/4

NEW WORLD-WIDE GRADUATE AWARD DIRECTORY. First compilation ever prepared for American scientists, teachers and librarians to subsidize their education and research in over 350 universities in 45 states, 30 foreign lands. Stipends $200–$10,000. Complete information. Pre-publication price before 15 Nov. 1957, $1.50. Regular price, $2. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. 10/4, 11, 18, 26; 11/1

POSITIONS WANTED

Bacteriologist, Ph.D.; experienced also in various metabolic studies. Academic-research or industrial-research. Box 266, SCIENCE. 10/4, 11

Biochemist; Ph.D.; 12 years' experience in pharmaceutical industry—4 years, research chemist and group leader; 8 years, director of research. Burneice Larson, Director, Medical Bureau, 900 North Michigan, Chicago. X

Research Administrator, Ph.D.; 35. Experience includes industrial pharmacology, toxicology, new product development and biological control. Box 264, SCIENCE. X

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Rates listed below — no charge for Box Number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

Single insertion	$22.00 per inch
13 times in 1 year	21.00 per inch
26 times in 1 year	20.00 per inch
52 times in 1 year	19.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . . **SCIENTIFIC PERIODICALS and BOOKS**

Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.

WALTER J. JOHNSON, INC.
111 Fifth Avenue, New York 3, New York

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, Inc. Boston 19, Massachusetts

SCIENTIFIC JOURNALS WANTED

Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals.
Abrahams Magazine Service; N. Y. 3, N. Y.

SUPPLIES AND EQUIPMENT

SWISS MICE
TACONIC FARMS
GERMANTOWN, NEW YORK — Phone 3535

NUCLEAR CHEMICAL CO.
RADIOISOTOPE LABELED COMPOUNDS
C-14, H-3, P-32, S-35
LABELED SUGAR COMPOUNDS
CUSTOM SYNTHESIS
1952 West Irving Park Rd. Chicago 13, Ill.

BOOKS AND MAGAZINES

THE LUMINESCENCE OF BIOLOGICAL SYSTEMS

edited by Frank H. Johnson

6" x 9", clothbound, 466 pp., genera and species, subject and author indexes, bibliographies

$7.00 ($6.00 for cash orders by AAAS members)

"The recent rapid development of bio-luminescence is well illustrated by the book and it should hasten the transition of the field from a highly specialized area to one having many points of contact with other parts of both physiology and chemistry." *American Scientist*, Autumn 1956.

The volume includes papers and discussion on fundamental aspects of "cold light" given at a recent international conference. Leading investigators provide a critical evaluation of current knowledge while exploring approaches to unsolved problems. The free interchange of ideas in the discussions intensifies the stimulating nature of the book.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
1515 Massachusetts Ave., NW,
Washington 5, D.C.

SUPPLIES AND EQUIPMENT

albino rats*

**Descendants of the Sprague-Dawley and Wistar Strains*

•

Hypophysectomized Rats

•

HENRY L. FOSTER, D.V.M.
President and Director
THE CHARLES RIVER BREEDING LABS.
Dept. B, Wilmington, Mass.

PROFESSIONAL SERVICES

NDI TOXICITY TESTS

following FDA procedures, for chemicals, foods, drugs, cosmetics, pesticides, additives. Biological assays. Screening tests. Complete research and development services. No obligation for estimates. Call or write Arthur D. Herrick, Director.

NEW DRUG INSTITUTE
130 East 59 St., New York 22 • Mu 8-0640

SUPPLIES AND EQUIPMENT

SWISS MICE

BACTERIOLOGICAL AND GROSS TISSUE STUDY TECHNIQUES USED IN OUR QUALITY CONTROL

HUNTINGDON FARMS, INC.
2548 NORTH 27th ST. PHILA. 32, PA.

Special LaMOTTE Reagents for Analysis

TIRON—for determination of Iron, Titanium, and Molybdenum

ZINCON—for determination of Zinc and Copper

★★★★

Send for LaMotte Catalog on CHEMICAL CONTROLS for **pH, Chlorine, Phosphates and Polyphosphates, etc.**

LaMotte Chemical Prod. Co.
Dept. H Chestertown, Md.

ALBINO RATS

Our mass production methods insure greatest uniformity and consistency

Price list on request

DAN ROLFSMEYER CO. ■ Ph. 6-6149
Route 3, Syene Road, Madison, Wisconsin

UNIFORM . . . . .
Webster Swiss ALBINO MICE
ARMER ENTERPRISES
Croton Falls, N.Y.

HOLTZMAN COMPANY

Our continuous efforts to maintain the superiority of the Holtzman strain of albino rats are centered on the environmental, nutritional, and breeding aspects. We submit that your published report may be more accurate if you state that the rats were procured from us. We believe they are better than those produced elsewhere.

Rte. 4, Box 205	Madison, Wis.	Phone ALpine 6-5573
6919 Burkett St.	Houston, Texas	Phone JAckson 9-1708

GET YOUR ADVANCE COPY

of the General Program-Directory of the AAAS Indianapolis Meeting by first class mail – early in December

The General Program-Directory of the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

Program content

1. The two-session general symposium, "Moving Frontiers of Science II: Concepts That Mold Our Lives," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Programs of the 18 AAAS sections (symposia and contributed papers).
4. Programs of the more than 60 participating societies.
5. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, Sigma Xi-RESA.
6. Details of the Murat Temple—center of the Meeting—and of the hotels and other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1957 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1957.
2. Complete roll of AAAS presidents and their fields.
3. The 271 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

Advance Registration

Advance registration has these decided advantages: 1) You avoid delay at the Registration Center upon arrival; 2) You receive the General Program-Directory in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program-Directory.

— THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM-DIRECTORY —

1a. ☐ Enclosed is $3.00 for my advance Registration Fee which brings me the Program-Directory, Convention Badge, and all privileges of the Meeting.

1b. ☐ Enclosed is $2.00 for only the Program-Directory. (It is understood that, if I should attend the Meeting later, the Badge—which is necessary for all privileges of the Meeting—will be secured for $1.00 more.)
(Check one)

2. FULL NAME (Dr., Miss, etc.) .....
(Please print or typewrite) (Last) (First) (Initial)

3. ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....

4. OFFICE OR HOME ADDRESS .....
(For receipt of Program-Directory)

5. YOUR FIELD OF INTEREST .....

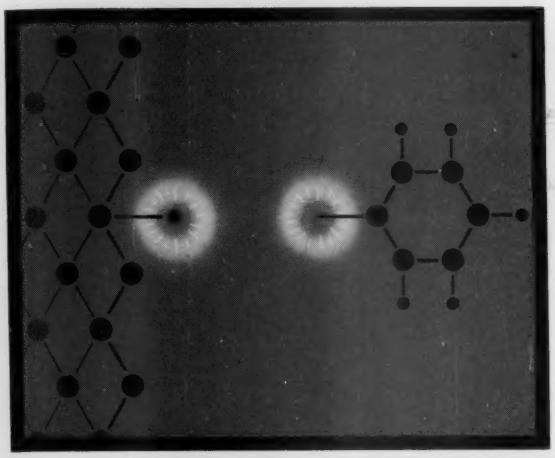
6. CONVENTION ADDRESS .....
(May be added later, after arrival)

Please mail this Coupon and your check or money order for $3.00 or $2.00 to the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
1515 Massachusetts Avenue, N.W., Washington 5, D.C.

A MAJOR CLUE TO BIOCHEMICAL REACTIONS

which E-P-R Spectroscopy furnishes the biologist

E-P-R AT WORK (Electron Paramagnetic Resonance) **8**



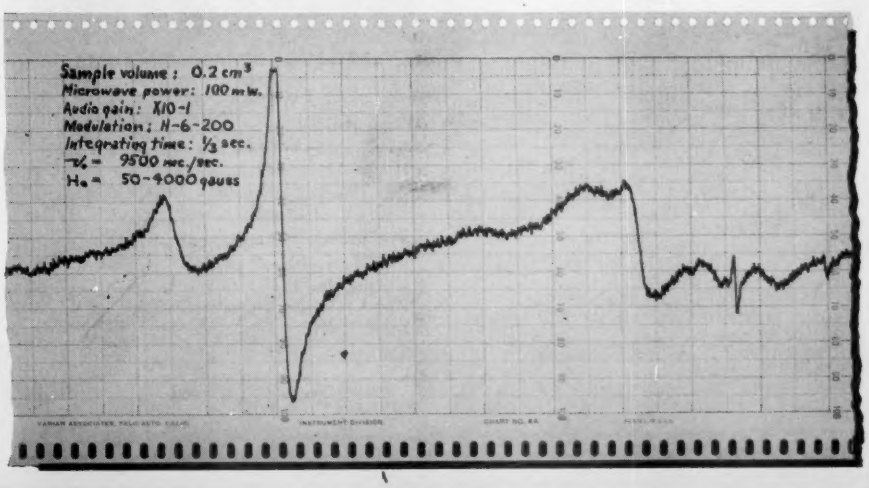
Is the odd molecule (or free radical) a necessary participant in most bio-chemical reactions? E-P-R's unique ability to determine its presence, identity, quantity and frequency of reaction can help unravel the vast complexities of life's chemistry. E-P-R spectroscopy is based on gyromagnetic properties of electrons and is particularly applicable to photosynthesis, enzyme substrate reactions, polymerization and radiation damage.

No other technique makes the same positive identifications. E-P-R Spectroscopy is singularly exclusive, "seeing" principally odd molecules and transition-element ions. It reveals quantity and identity, by measuring interaction of the odd electron with its surrounding nuclei. From E-P-R signals under varying temperature and chemical environments, the scientist can determine reaction kinetics.

E-P-R spectroscopy is non-destructive to life or chemical processes. Typical sample is 0.15 cc in a quartz tube. Concentration of the odd molecule can be as low as 10^{-8} molar if adequately separated from signal-masking impurities. Example below is one of a continuing series.

Number 8 of a series **DAMAGE FROM FREEZE DRYING IN WHOLE BLOOD**

INTERPRETATION: Some attempts have been made to correlate EPR signals in lyophilized materials with metabolic activities. An interesting sideline of this research has been the observaton of free radicals arising from broken bonds due to the freeze drying. The spectrum shown below is that recorded from lyophilized whole human blood. It reveals damage in two ways: first one observes the trivalent and divalent iron absorptions, indicating not only the conversion of hemoglobin to methemoglobin, but also damage to both of the molecules; second one sees the small sharp line to the right which is associated with a free valence. Preliminary experiments indicate that this free valence is produced by the breaking of the porphyrin ring structure.



For full technical details on E-P-R and N-M-R Spectroscopy and Spectrometers, write to the Varian Associates Instrument Division

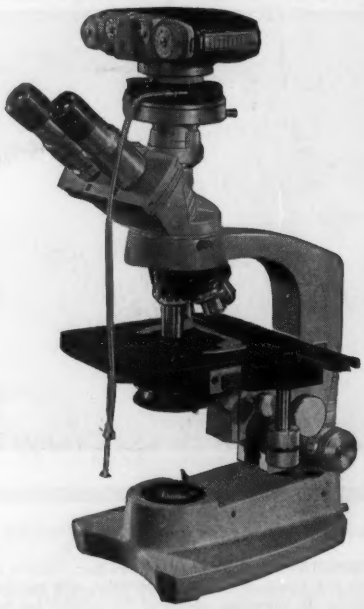
VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 18, CALIFORNIA

2 COMPLETELY **NEW** LINES

BY AMERICAN OPTICAL COMPANY

MICROSTAR

LABORATORY MICROSCOPES



Outstanding Features:

- Advanced styling and design
- Interchangeable and reversible bodies
- Rigid, well balanced arm
- Focusable stages . . . Variable autofocus
- Wide selection of mechanical stages
- Dual cone revolving nosepieces
- Zone of convenience
- Built-in base illuminator
- Top quality optics
- New EPOXY finish

Plus—

Wide variety of accessories and alternate parts . . . readily interchangeable to meet future needs.

CYCLOPTIC

STEREOSCOPIC MICROSCOPES

Outstanding Features:

- True three-dimensional erected image
- Top quality optics . . . low reflection coated
- Reversible and inclined body
- Long working distance
- Large field of view
- Wide range of magnifications
- Broad selection of models
- Dove-gray EPOXY finish
- New Cyclospot Illuminator
- LOW PRICE

Plus—

Revolutionary MAGNI-CHANGER . . . desired magnifications simply "dialed in"!

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. U-4

Gentlemen:

- ☐ Please rush new CYCLOPTIC brochure SB 56
- ☐ Please rush new MICROSTAR brochure SB 124

Name_____

Address_____

City_____ Zone____ State____

DEFENSE PRODUCTS PLANT • KEENE, NEW HAMPSHIRE